OIL, GAS AND PETROCHEMICAL PROCESSING

Petroleum Refiner

JANUARY
1959

# OIL CENTENNIAL ISSUE

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Including . . .

World Energy and Oil • Predictions by Top Energy Experts • Chemical Use of Oil in 1984 • The Training Challenge • New Concept in Engineering Education

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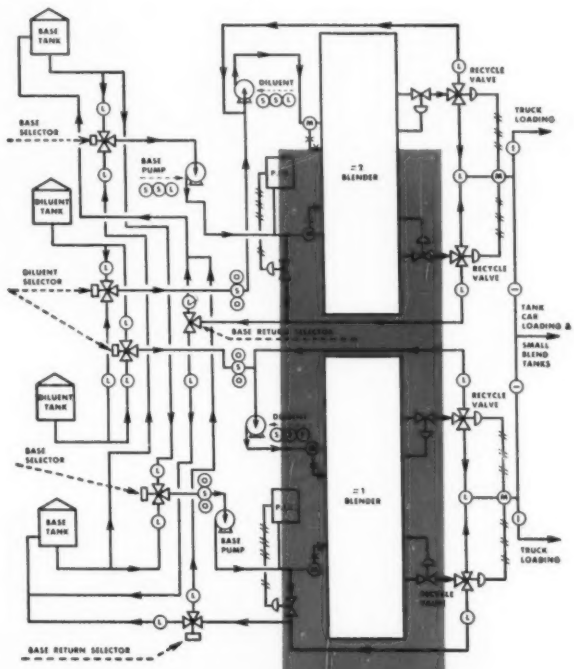


At Phillips'
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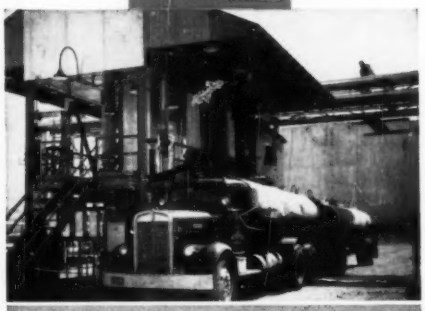

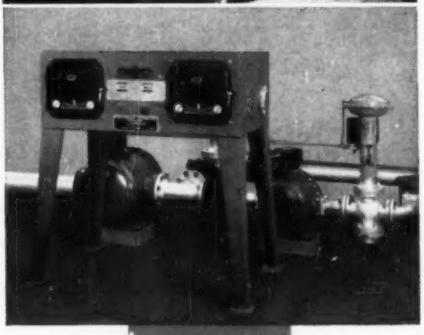

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Volume 38, No. 1 January, 1959

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**Petroleum Refiner**

OIL, GAS AND PETROCHEMICAL PROCESSING

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# A Quick Look

## at This Issue

These handy digests permit checking ☑ the articles you want to read first.

### CENTENNIAL SPECIAL REPORT

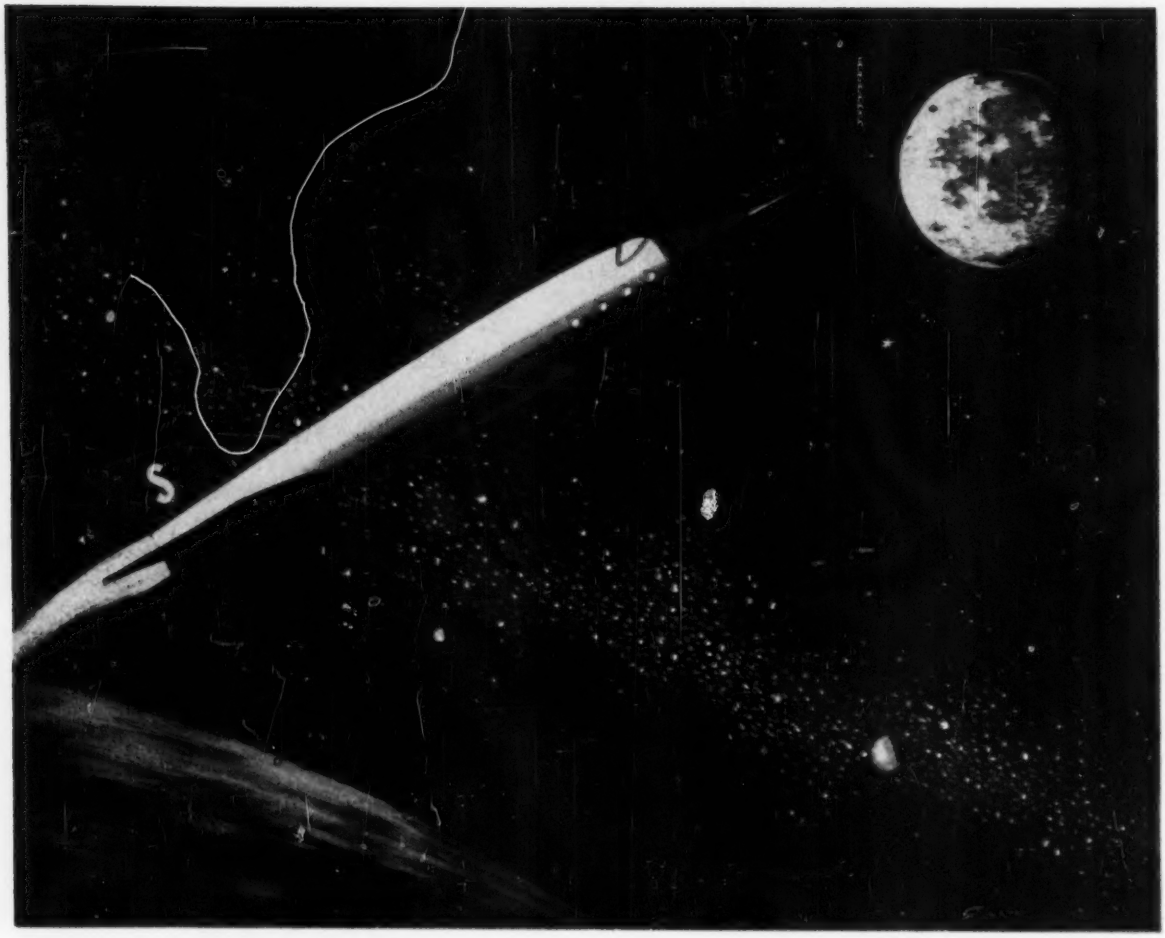
☐ **The Refining Story . . .** Here is a story that paints the whole picture of the development of the refining industry. Unlike many histories, however, "The Refining Story" has retained all of the intrigue, color and humor that accompanied the technical progress. It's completely accurate and informative and reads like a best seller. Don't miss it starting on **Page 146.**

☐ **The Natural Gasoline Story . . .** You'd be surprised how much the old-timers knew about making gasoline in the early days of the industry. By 1918, they had applied all the basic processes now used today. Their calculations were pretty crude but you'll admire the developments as they unfolded in this colorful history starting on **Page 165.**

☐ **The Petrochemical Story . . .** Traced from its meager beginnings, the petrochemical industry has developed into the most promising offspring of the oil industry. For instance, who would have thought 30 years ago that the waste gas ethylene, would today be in every home as the familiar squeeze bottle. This development and many others are traced for you in this highly interesting and informative petrochemical history starting on **Page 179.**

☐ **Refining Hall of Fame . . .** At last here are the names of those eight individuals selected by the readers and editors of PETROLEUM REFINER as having contributed the most to the oil, gas and petrochemical processing industry. Turn to **Page 188.**

**Please Turn Page →**



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For more data on advertised products, use Readers' Service Cards, last page.

## A Quick Look at This Issue . . .

☐ **World Energy and World Oil . . .** Life will be vastly different in 25 years, and it will take a tremendous amount of energy to conduct world-wide activities. This long-range glimpse into the year 1984 gives you the picture of how much energy will be needed in the world, and the part oil will play in this picture. Then there are eight short articles by top energy experts indicating the share of the world energy market that will be grabbed by nuclear energy, shale oil, tar sands, gilsonite, coal and lignite, solar energy, high energy fuels, and miscellaneous forms of energy. This one is a must for present information and long-range planning. Turn to **Page 192.**

☐ **Chemical Use of Oil May Wane . . .** At last here is a story on how the chemical industry views the long-range use of petroleum. The author feels that within the next 25 years, certain factors may force more use of coal and its by-products and shale oil as chemical raw materials. Here's one article you'll be sure to clip for your economic and cost files. Turn to **Page 205.**

☐ **A Training Challenge . . .** Probably one of the greatest changes that will take place within the next 25 years will be in the training director. Here's a highly interesting article on how he will have to develop, the areas in which he will have to improve, and just what will be expected of him by 1984. Be sure to turn to **Page 207.**

☐ **In Engineering Education—A Dynamic New Concept . . .** We're going to have a brand new educational system for engineers, which will no doubt be started at some big eastern college. By then, present day universities will be mostly graduate institutions, and today's junior colleges will increase course offerings to the junior and senior level. One possibility may be that students will go for 36 straight months, then take a year's internship in industry, then back to school. You'll get a glimpse of the future in this article which starts on **Page 208.**

---

☐ **The Inside Story on Code Inspection . . .** Here's what you need to know about the ASME pressure vessel code, what it requires of vessel inspection, and the steps necessary for code qualification. Whether you specify or build vessels, knowing these inspection tips will pay off with less frustration and time loss when your vessel is ready for inspection. For complete details, turn to **Page 211.**

☐ **Find Blend Viscosity by Nomograph . . .** In determining viscosities of oil mixtures, you will find that the cube roots of the viscosities are linear functions of the compositions. Do You like to do cube roots? If not, use the nomograph on **Page 216.**

☐ **Use Enthalpy for Two-Phase ΔP . . .** Here's a method which eliminates much of the trial and error when calculating pressure drop in fired heaters with vaporizing fluids. By using thermodynamic relationships you'll get direct calculations of this tedious design problem. New method, old principles, but a real time saver, turn to **Page 217.**

☐ **Heat Transfer Nomographs. . . Part 4: Prandtl numbers for gases and liquids . . .** you can shorten heat transfer calculations, by using these two nomographs to determine Prandtl numbers for liquids and gases. This useful tool is another must for your data book. Turn to **Page 223.**

☐ **How Computers Up Refinery Profits . . .** With 209 products to control, Champlin programmed inventory control, operation costs and determined optimum profits. You'll find daily weight balances around each unit and linear programming for gasoline blending. Study these results carefully, they can mean money in your pocket. Turn to **Page 225.**

☐ **Estimate Latent Heats Rapidly . . .** and accurately too with this new method. This one has been compared with many experimental data and you'll be amazed at the accuracy possible. You'll want to save this one for the notebook, so see **Page 233.**

☐ **Work Simplification Really Pays Off! . . .** Here's how one company is using the theme "Work smarter, not harder" to save dollars and to boost employe morale. For instance, a recent 14-week course yielded cost reductions which will save an estimated $52,000 yearly—on a training investment of just about $1,000. You can read all about it by turning to **Page 303.**

☐ **'Blind' Supervisors Learn Safety Fast . . .** There is no doubt that one of the best ways to realize the value of sight is to experience the helplessness that accompanies "going blind." Here's how Esso Research and Engineering is impressing that fact on its supervisors. For a fast reading picture story, turn to **Page 312.**

☐ **Patent Law You Should Know . . . How to Invent: Part 6 . . .** At last, here is a concise and easy-to-understand run-down on the patent laws you need to know to protect your ideas, to obtain a patent and to get the most benefit from your invention. You're going to want to be sure to clip this one and add it to the rest of your "How to Invent" file. Be sure to turn to **Page 316.**

# "Oilwell" Bull Plugs and Swaged Nipples

## *and secure quality that is safe to use in restricted areas*

**For restricted areas in refineries and petrochemical plants** . . . are you as particular about the specifications of your bull plugs and swaged nipples as you are about the piping with which they are used? Sizes 2″ and under in "Oilwell" bull plugs and swaged nipples are machined from AISI-1015 special bar quality of open hearth steel. We do not use screw stock or high carbon steels, which would not make reliable fittings for hazardous refinery operations.

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PETROLEUM REFINER and The REFINERY CATALOG for the oil, gas and petrochemical processing industry.

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PIPE LINE INDUSTRY and The PIPE LINE COMPOSITE CATALOG for the oil and gas pipe line industry.

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**Industry guests help PR editors plan.**

# Planning Conference

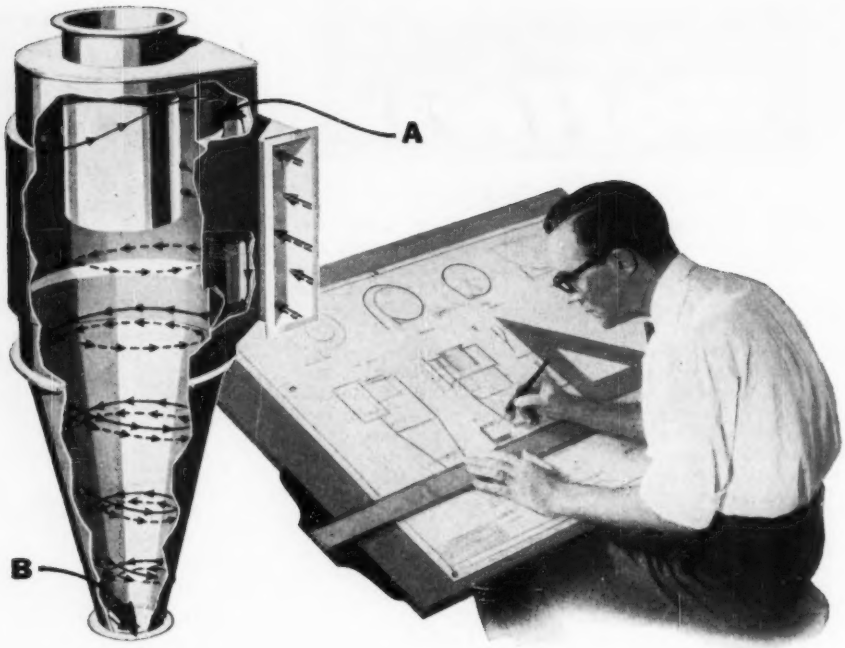
INDUSTRY GUESTS attending PETROLEUM REFINER's annual editorial conference sessions at old Fort Clark, Texas, came from near and far. But whether their home base was Baytown, Texas, or Los Angeles, Calif., the results were the same, viz., sound criticism and suggestions that should result in an improved and better rounded PR service—the very best—for those engaged in oil, gas and petrochemical processing. This is PR's constant aim and these annual conferences attended by the entire staff plus experts from the processing field help us attain that goal.

Pictured above are our 1958 Conference guests. They are, l to r, Dr. J. R. Fair, in charge of Engineering Research section, Monsanto, Dayton, Ohio; Robert L. Mueleners, process design section head, Amoco, Texas City; W. D. Allison, supervising engineer, Machinery Engineering section, Humble, Baytown; Dr. C. T. Wells, president, Goliad Corporation, Houston; and Ted Weaver, manager of process development, Fluor, Los Angeles.

Attendance by these men doesn't necessarily constitute an indorsement of PR or its policies, but we want to acknowledge their presence among us and thank them for giving of their time and talent in our pursuit of better things for PR readers.

# A Pat from Afar

AN INTERESTING RESPONSE to our "Calling All Ol' Timers" appeal (PR, October 1958) came from Aleksander Mosic, chief technologist of Petroleum Refinery Sisak, in Sisak, Yugoslavia. He referred to Walter Fisher, who was technical manager for many years of the Sisak plant. "When he saw my copy of PR come in," Mosic writes, "he approved it heartily and promised to bring from his home one of PR's early issues 'to show you how PR has developed and how this development was in line with the growth of petroleum technology.'" We appreciate this word and the kind things that Mosic added about PR. Our big regret is that we didn't get some early PR reminiscences from Mr. Fisher, veteran reader of this magazine, before his death three months ago.

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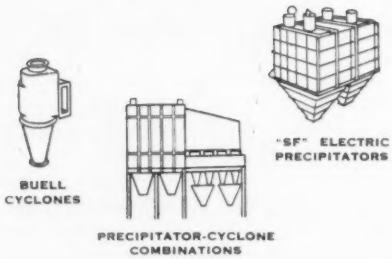


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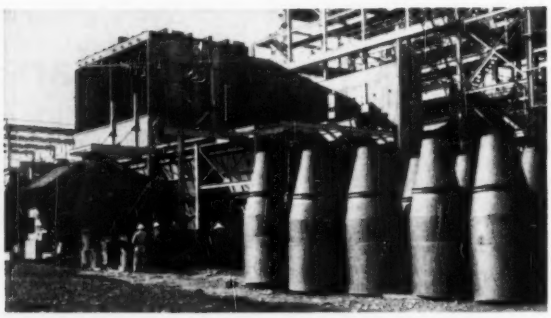

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# A Quick Look at the Industry THIS MONTH

***Keep Your Eyes on These Five Developments in '59***

**1. *Possible Mandatory Controls of Oil Imports* . . .** Washington-based rumors continue that mandatory federal controls on oil imports are just around the corner—but so far it's much talk and little fact. True, so-called "Carson Plan" is squeezed between industry objections on one hand and Justice Dept. opposition to "historic importing" on the other—then add ever-increasing pressure of independent producers for mandatory controls, it may be enough to squeeze voluntary plan right out of existence.

**On other side of ledger, however,** stand Canada and Venezuela—and their possible reactions. Canada could retaliate by substituting barred Canadian crude for that now being imported from U. S.—thus a stalemate. As for Venezuela, many are fearful—especially considering government is still in "transition" period and eager to please population.

**On top of this, mandatory controls would swing** wide the door for other industries claiming to be hard hit by "cheap foreign imports."

**2. *Product Demand to Increase* . . .** Aided by severe winter weather, "oil product demand in first half of '59 is expected to increase by 5 percent over '58 first half," contends Indiana Standard chairman, Prior.

**Conoco president, McCollum, makes this forecast:** "Refinery runs should increase approximately 5 to 6 percent. The increase in demand should restore product prices to more satisfactory levels, providing the industry continues to exercise common sense with regard to inventory management."

**Long Range Forecast: Chase Manhattan predicts** Free World demand jump to 29.5 million barrels daily in '67—U. S. demand rise to 14.4 million barrels by same year. For 25-year prediction, see page 192.

**3. *Tax Incentives for Foreign Investments* . . .** U. S. presently considering granting more tax credits as incentive for U. S. corporations to invest overseas. Now, U. S. industry abroad doesn't benefit from temporary income tax incentives and exemptions developing countries offer. Having smaller foreign tax credit, corporation must pay correspondingly higher U. S. tax. Thus frustrating effort of developing country to attract American capital by tax inducements.

**Under "tax sparing" provisions being studied,** U. S. corporations would get tax credit in U. S. for income taxes "spared" by foreign countries as investment inducement.

**All in all, it's good business for Uncle Sam.** With private dollars in countries, not as much has to be given in foreign aid.

**4. *New Venezuelan Tax Hike* . . .** Provisional government of Venezuela suddenly invoked new tax decree subjecting foreign-owned oil companies to same graduated tax on profits paid by Venezuelan firms—retroactive to 1958. This will probably give 60 percent of profits to Venezuela as opposed to 51 percent in '57.

**Said Creole Petroleum president Haight,** "New income tax law is hard blow at

oil industry of Venezuela and, in my opinion, has drastically altered the climate of foreign investment in this country."

**Jersey Standard chairman Holman** contends tax decree "decreases incentive for private capital to invest in Venezuela."

**If Venezuela gets away with it,** others will probably follow.

***5. Unions, Oil and White Collars . . .*** In strike votes taken, more than 90 percent of workers covered by OCAW's 600-odd oil contracts agree to strike if necessary. On top of that, OCAW president Knight claims membership is "more militant than we have ever been, and it can be traced right back to the arrogant attitude of the companies . . ."

**Also, in efforts to expand spheres of influence,** Unions are devoting much time and effort to planning organization of white collars—are considering separate unions with air of distinction. Look for stepped-up activities here.

***Bayway Pilot Plant Automated . . .*** Esso readying installation of completely automatic pilot plant at Bayway refinery. Purpose: catalyst studies for catalytic reforming technique. Esso believes it represents new dimension in pilot plant concept and operation.

**Another development finds Esso R&E with new** stationary snow melter; melts snow fast as it accumulates. Based on submerged combustion principle, it burns oil with 98 percent efficiency. Cost: about 25 cents to clear car space during 8-hour snowfall—one-third cost of trucking. Best markets: airports, parking lots, shopping centers.

***Propylene O.K. in Motor Fuel . . .*** LPG producers are all smiles over recent tests showing no harmful effects of propylene in motor fuel. Blend of 47 percent propylene will cause no more engine trouble or knock than does 100 percent propane. On better designed engines—no knock, no trouble.

***Crops, Bugs, and Petrochemicals . . .*** Farms becoming big business for petrochemicals as late estimate claims agricultural chemicals (principally petroleum-derived) will be $3.25 billion market by '75. Fertilizers will grab lion's share with $2.25 billion annually while insecticides, weed killers, and pesticides reach for $1 billion. Petrochemicals have already cut insect losses in half but bugs still eat $3 billion worth of crops annually—quite a challenge!

***Quick Look Around the Country . . .*** Justice Dept. files another oil anti-trust suit—this time against Jersey Standard, Esso, and Standard of Kentucky charging restraint of trade in product distribution . . . **Supreme Court ruling** on much publicized "Memphis Case" says pipe line companies do not have to get customers' O.K. to file rate hikes with Federal Power Commission . . . **SunOlin Chemical plans** new urea plant near Sun Oil's Marcus Hook refinery.

***Closed Circuit TV . . .*** Closed circuit TV used as operating instrument in gasoline plant now at Pan American's Slaughter, Texas plant. Installation permits steam boiler operator to monitor critical sulfur unit control instruments from central work location 260 feet away.

***Union Carbide In At Brownsville . . .*** Union Carbide buys from Amoco Chemicals all utilizable facilities of its former processing plant (old "Hydrocol" installation) at Brownsville, Texas. Carbide will make certain additions to the site but won't produce synthetic gasoline, petroleum products or Fischer-Tropsch process chemicals.

# Where a misstep costs $500... Blaw-Knox Electroforged® Steel Grating provides safer non-slip footing

*Stair falls cost industry over $60,000,000 a year.*

An average accident amounts to a loss of $500 in claims.*

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Made to your specifications, Blaw-Knox grating provides new highs in safety, easy up-keep and flexible application. For new ideas about grating—including space saving platforms and shelving, write for Bulletin 2527.

*Based on a study analyzing 803 compensable work injury claims closed in Illinois involving stairs and steps.

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For more data on advertised products, use Readers' Service Cards, last page.

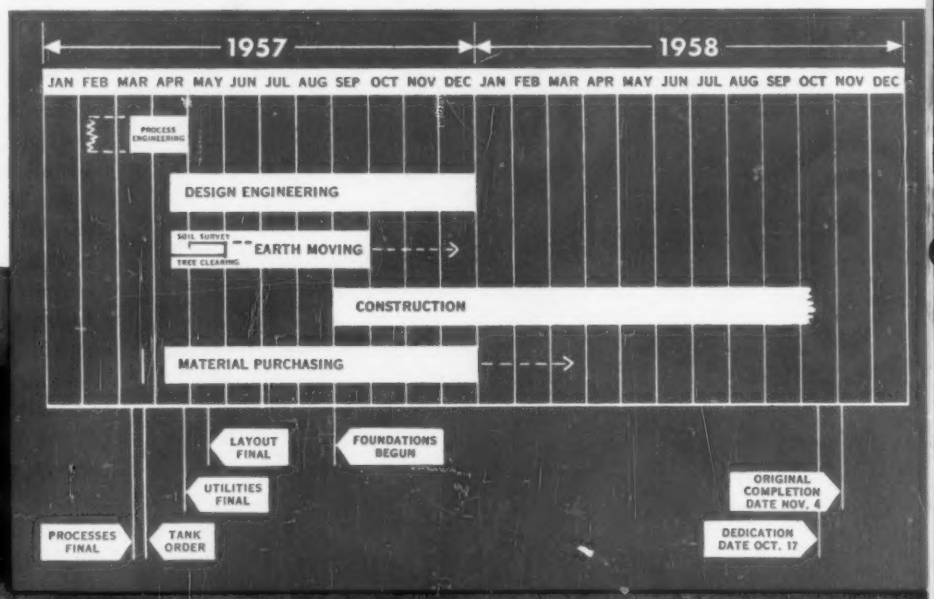
# Unique Teamwork

## Speeds Completion of B/A's Port Moody Refinery

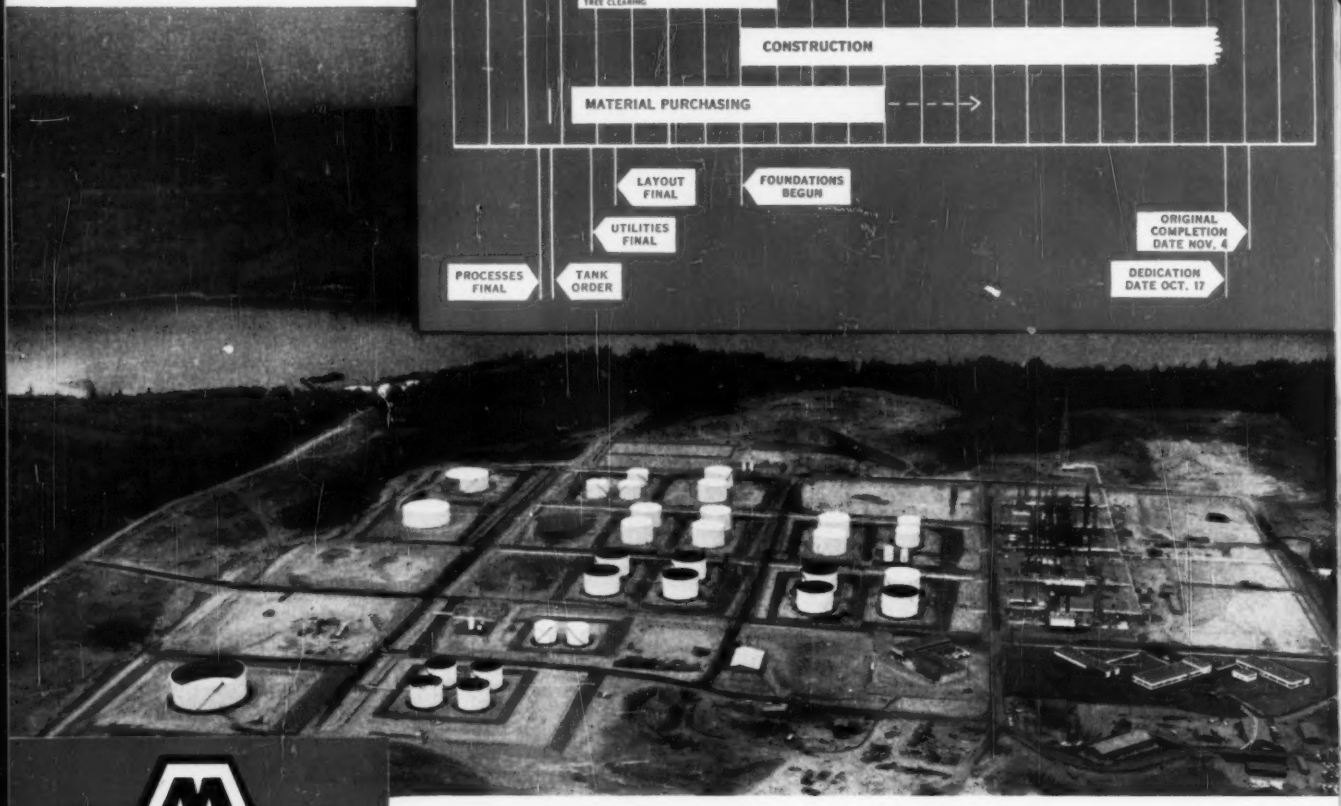
Foreseeing unusually rapid changes in the West Coast marketing situation, the British American Oil Company in the Spring of 1957 decided a new "grass roots" refinery was required in the Vancouver area by the Winter of 1958. Eighteen months or so is a short time to plan and execute a refinery project. Canadian Kellogg's accomplishment of this unusual speed record is a testimony to the B/A organization and its ability to delegate decision-making. Working with a special team of B/A engineers who could make decisions "on the site", Kellogg completed the project ahead of schedule.

One of the first things Canadian Kellogg required were horses—the only transportation the engineers could use to negotiate the muddy conditions on the site. But a strategically placed drainage and pumping system soon dried the ground and proved so effective that after its installation not one day's labor was lost through wet conditions. Other practical solutions to construction problems, plus the most advanced chemical engineering, have made the investment per barrel capacity of the B/A Port Moody refinery relatively very low.

Right from the start Canadian Kellogg's experience and B/A's cooperation pushed the job ahead of schedule. Of course, B/A and Canadian Kellogg have worked together before. The Port Moody contract was awarded to Canadian Kellogg mainly on past performance . . . this move in itself saved the time and money normally spent preparing and analyzing detail bids. Mutual respect between client and contractor was one of the outstanding factors that contributed to the speedy completion of the project.




Right: *Chart shows rapid construction progress made on the Port Moody project.* Below: *Air view of new B/A Port Moody refinery, Vancouver, British Columbia. Process section, right, is subdivided into five areas: (1) Crude Unit, (2) Catalytic Reformer and Distillate Desulfurization Unit, (3) Utility Plant, (4) Orthoflow® Fluid Cat Cracker, and (5) Alkylation Unit.*



KELLOGG

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# History—Portent of Oil's Future

CERTAINLY ONE OF THE GREAT VALUES of any history is that it establishes a pattern which enables us to gaze into the immediate future with some fair degree of accuracy. You may hear the average businessman say that he does not care one iota about history—be it economic, social or political. However, when we think about it, few people make more constant use of history than do successful businessmen. With the view of determining future company policy or direction, they examine their previous records and interpret them in conjunction with prevailing economic conditions. By using this barometer, they are able to ascertain the trends of tomorrow.

Certainly the future may not unfold as is anticipated, but if all factors have been carefully analyzed, chances of failure are fewer than if decisions are made by rule of thumb. Having just completed preparing the histories of refining, petrochemicals and the natural gasoline industry, it is interesting to extend some of these patterns to see what tomorrow will hold.

As for refining, it is interesting to note that our present cycle of high octane numbers and product-improving processes commenced in 1930 when the octane number concept was introduced in order to give manufacturers some indication of the gasoline quality. Thus began a new era in refining; not only did the refiner need to concern himself with higher gasoline yields from a barrel of crude, but he also took on worries as to the quality of his product. Of course, this made catalytic cracking all the more desirable and set the stage for reforming, alkylation and isomerization to make a strong entry into refining.

**Tailor-Made Product.** Of course, octanes are not the only yardstick of quality which has continued to foster technological advances. The search for cleaner, more stable fuels has brought on hydrogen treating in full force. Fortunately, catalytic reforming has furnished the necessary hydrogen for this treating technique, although in some cases the hydrogen requirements are so high that specific hydrogen producing processes are installed.

Thus, the present highly competitive market for motor fuels requires modern refiners practically to tailor-make gasoline to satisfy particular demands. In the opinion of some, this technology has become so specialized that we no longer think of crude oil in its gross sense, but rather as a mixture of individual chemicals.

In the future, we can look for additional developments which will permit us to separate these components more easily so that we may meet the requirements of motor fuel as a chemical blend.

In studying the past of the natural gasoline segment, we were astounded not by what was unknown in the early days but by how much was known. Indeed, by 1918, natural gasoline had the basic processes which are used today. There have been refinements; in fact any engineer-constructor will tell you that your pencil really has to be sharp in bidding on a natural gasoline plant. At the same time, the industry is ripe for new, cheap processes for recovering liquids from natural gas. This is one route the industry could take in the future.

**Natural Gasoline Problems.** Basically, though, the natural gasoline industry's problems are not too different from those in the early days. Rather than process technology, the problems then and now and for the future are 1) a reasonable price for natural gasoline in motor fuel use, 2) more independence from the refiner's market, 3) the avoidance of seasonal markets.

Thus, in motor fuel blends, the refinery with catalytic cracking is able to handle fuel volatility well within his own plant. Natural gasoline has suffered in the octane race and has now become more of a feedstock for upgrading units, rather than a blending stock. The natural gasoline man can in the future put in these upgrading units at his own plant but he will meet head-on with competition from the refiner, who will be doing the same thing on a bigger basis.

Seasonal markets are still here even with long range contracts on natural gasoline. But the refiner has found it advantageous to buy more in the winter months than in the summer months. Underground storage of LPG has helped tremendously; and there's no doubt its importance will continue in the future.

A very bright future would be in store for natural gasoline should autos go to a turbine engine. Saturated hydrocarbons in the gasoline range would be top notch blending stocks; and natural would no longer suffer an octane penalty.

On a very long range basis, natural gasoline will increase in value for the simple reason that oil and gas are a limited resource in the total energy picture.

**The Petrochemicals Picture.** On the petrochemicals

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## 1¼% — 2¼% — 5%

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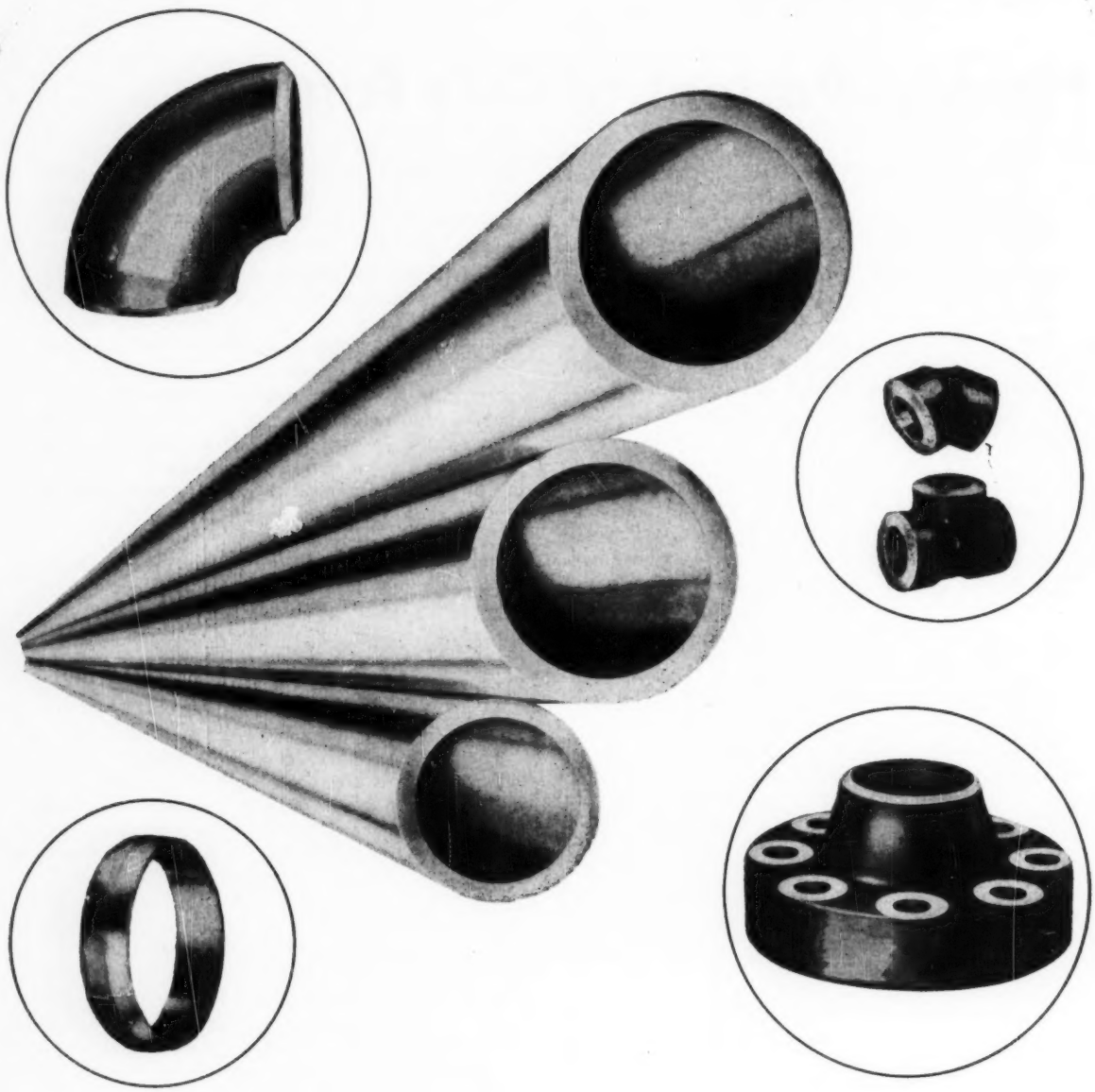

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side of the triangle, we see that petrochemicals mean much more than chemicals from petroleum and natural gas. They are the accepted standard of synthetic organic chemicals. From a very meager beginning, petrochemicals now account for more than 30 percent of the entire chemical production. And all this from only about 2 percent of the total natural gas and petroleum produced. Petrochemicals have *grown* so fast that they have doubled every five years. Yes, indeed, petrochemicals are the fastest *growing* portion of the entire petroleum industry.

To appreciate the effect of petrochemicals on our everyday life, one has only to reflect a moment on such wonderous products as polyethylene, synthetic rubber and ammonia. Principal contribution of the petrochemical industry has been superior products at lower prices and steady supply. Even more difficult to imagine than what we would have done without them is to visualize what may be expected in the future. Petrochemicals have just begun to contribute to our complex industrial advance. Tomorrow holds many exciting developments which can and will come only through intensive and creative research. Petrochemicals are moving so rapidly that a moment's distraction from the current scene can result in being far behind the times.

Commercially and financially, petrochemicals have contributed much. The leading chemical companies are almost entirely petrochemical based. Today the trend is decidedly toward petroleum as the desired raw material for chemical and thus petrochemical production. Take a look at the portion of the earnings petrochemicals have contributed to many of the major oil and chemical companies. In the immediate future, this percentage of earnings from petrochemical ventures should increase.

Now be sure to read "The Refining Story," (Page 146) "The Natural Gasoline Story," (Page 165) and "The Petrochemical Story" (Page 179) Three histories—portents of the future.

## Prescription For Victory

WORKING HARD in schools and in our creative laboratories, working hard to develop new techniques, never being satisfied with today's achievements but instead searching, ever searching for improvement.

That's what will keep America in the superior class and it's a prescription that had best be followed by all who are interested that we stay ahead in this space age.

Certainly it's a sounder course to follow than to lie back in the bed of contentment satisfied that no nation's people can ever overtake us.

This "we are the best in the world" feeling is the thing that breeds arrogance and that in turn can bring about false security and a nation's downfall. This is particularly true when the world is divided into two camps both striving for the essential victory.

Hercules Powder Company's head, Albert E. Forster stresses this thinking in strong language:

"History gives us our warning, clear and unmistakable, in the fate of once powerful nations which dulled their competitive spirits by arrogance, by a belief in their superiority, and by a denial of the basic qualities which made them great.

"Above all else, Americans must completely discard their dangerous reliance on the easy way. We must work harder on the job, and we must revitalize the unbeatable American revolutionary spirit which gave birth to our country, built it into powerful maturity, and can sustain that power here and abroad against all assaults."

In this fight, true, we have delivered some effective blows, but while 1959 is still young it might be a good time to resolve that we'll rid ourselves of any feeling of superiority and install in its place a determination to strive hard for "revitalization of the unbeatable Amercan spirit."

## The Senator States His Views

RECENTLY, PETROLEUM REFINER sent Senator Lyndon Johnson (D-Texas) a copy of "It's Our Last Line of Defense," the lead editorial which appeared in our October, 1958 issue. Since this editorial dealt with the role labor and unions are playing in politics, we asked the Senator just what he thinks of the powerful influence labor unions have over Congressmen and the nation's legislative program.

We received this reply:

"My immediate reaction is that I believe in full participation in our government by all citizens regardless of their economic position in the community.

"America is made up of many diverse groups and of many different regions. We achieve our best results in arriving at decisions that affect the whole nation when everyone of the groups and everyone of the regions has had its fullest and most complete opportunity to make its voice heard.

"I am opposed to any one group or any one section having an undue voice which mutes those of other groups and other sections. And as I have said in the past, collective judgment which reflects the thinking of all of our people in the long run is the best judgment.

Sincerely,
Lyndon B. Johnson"

Now that the senior senator from Texas has made incontrovertably clear his views on big unionism's billowing strength in national politics, we'd like to express this, one of our views:

Isn't it refreshing when you find a man, whether in politics or not, who will voice his frank opinions rather than laying down a barrage of words in hopes he can effect enough of a diversion to get the questioner off his neck?

TABLE I

## Effect of changing olefin distribution

(10% Light Olefins replaced by 10% Heavy Olefins)

| CAR | DEPRECIATION, OCTANE NUMBER | | | | |
|---|---|---|---|---|---|
| | 1000 RPM | 1500 RPM | 2000 RPM | 2500 RPM | 3000 RPM |
| E | — | + 1.1 | +0.3 | +0.7 | +0.9 |
| F | — | — | +0.4 | +0.4 | +0.5 |
| R | +0.2 | +0.4 | +0.3 | +0.5 | +0.4 |
| Average | — | +0.8 | +0.3 | +0.5 | +0.6 |

The increase in octane number depreciation is shown above when 10 per cent light olefins (<210 deg. F.) are replaced by 10 per cent heavy olefins (>300 deg. F.). Cars E, F, and R are 11-to-1 C. R.

# New study shows that the boiling range of hydrocarbons affects road antiknock performance

TWO GASOLINES with the same Research octane number, the same Motor octane number, and the same overall hydrocarbon type composition can differ significantly in road antiknock performance. This variation has been related to different placement of hydrocarbon types in the boiling range of gasolines.

Such was the general conclusion resulting from a program carried out at the Ethyl Research Laboratories in cooperation with a technical group of an oil company.

### Why Such a Study

Research and Motor octane ratings are generally accepted specifications for gasoline antiknock quality. Laboratory octane number is both a convenient and simple means of control. Results are easily applied to refinery economic studies of motor fuel components.

But the basic refinery problem is to build into gasoline an octane quality that pays off in road performance. Considerable research in recent years has been aimed at empirically correlating laboratory tests with actual road ratings.

As a result, calculated road octane numbers are now accepted as a means of establishing relative road performance of gasolines.

Present road rating equations relate road performance


For more data on advertised products, use Readers' Service Cards, last page.

to Research and Motor octane number and hydrocarbon composition. During the studies to formulate these equations it became apparent that, in addition to the hydrocarbon composition of the whole fuel, the distribution of the various hydrocarbon types in the boiling range was also significant.

Thus, fractional hydrocarbon effect became a logical subject for isolated study.

### Fuel Design and Inspection

For this study, 20 fuels of 100 Research octane number were designed to the specifications in Table II. Each test fuel was blended to provide variations in hydrocarbon type in each of four boiling fractions—$C_5$-210 degrees F., 210-250 degrees F., 250-300 degrees F., and over 300 degrees F.

These four fractions comprised 40, 20, 20 and 15 per cent respectively of each blend. The remaining 5 per cent was normal butane to fill volatility needs.

Realistic gasoline components were used as shown by two example blends in Table III.

Comprehensive laboratory inspections of the fuels and fractions represented more than 700 laboratory antiknock ratings, 400 hydrocarbon-type evaluations, and complete volatility data.

### Test Vehicles and Rating Procedure

Each of the 20 experimental gasolines was evaluated in six test vehicles. Three were 1957 and 1958 production models; the rest had experimental engines of 11-to-1 compression ratio.

Both Modified Borderline and Uniontown techniques were used in the rating program.

### Effects of Hydrocarbon Fractions

The following specific conclusions were noted:

1. Low-boiling olefins ($C_5$-210 deg. F.) generally provide better road octane performance than do high-boiling olefins (over 300 deg. F.).

2. Low-boiling aromatics (less than 300 deg. F.) seem to perform better than high-boiling aromatics (over 300 deg. F.) at lower speeds in each car. There is no significant difference at higher speeds.

3. There are no significant differences in road octane number due to the distribution of aromatics between 250 deg. F., and 300 deg. F.

**TABLE II**

**Fuel Specifications**

1. Nominal Research octane number (RON) of 100.
2. Tetraethyllead concentration of 2.5 to 3.0 ml. per gallon.
3. Distillation temperatures at the 45%, 65% and 85% evaporated points of 210, 250 and 300 deg. F. respectively.
4. Volume of normal butane at 5 per cent.
5. Nominal Reid vapor pressure of 7 psi.

**TABLE III**

**Composition of Test Fuel Fractions**

| Blend No. | $C_5$-210° F. | 210-250° F. | 250-300° F. | Over 300° F. |
|---|---|---|---|---|
| | % Component | % Component | % Component | % Component |
| 11 | 28 Cat. Poly.<br>12 Pentene-2 | 20 Toluene | 18 Straightrun<br>2 Normal Octane | 15 Mixed Aromatics |
| 18 | 32 HF Alkyl. Cut<br>8 Isohexane | 8 Normal Heptane<br>2 Isooctane<br>10 Toluene | 7 Straightrun<br>3 HF Alkyl. Cut<br>10 Mixed Xylenes | 15 Cat. Poly. |

Note: All blends contained 5% normal butane.


## How Ethyl Research is helping you

As a part of their regular program, Ethyl Corporation's Research Laboratories are continually investigating the variables that affect road performance. Frequently, programs take the form of special studies for individual customers.

Other programs are for the benefit of the entire Industry and occasionally are studied jointly on a cooperative basis with other companies.

The project discussed above was reported in a joint technical paper at the S.A.E. National Fuels and Lubricants Meeting in Tulsa, Oklahoma, November, 1958. Reprints of this paper are available through your Ethyl Representative, or by writing Ethyl Corp., 100 Park Ave., New York 17, N. Y.

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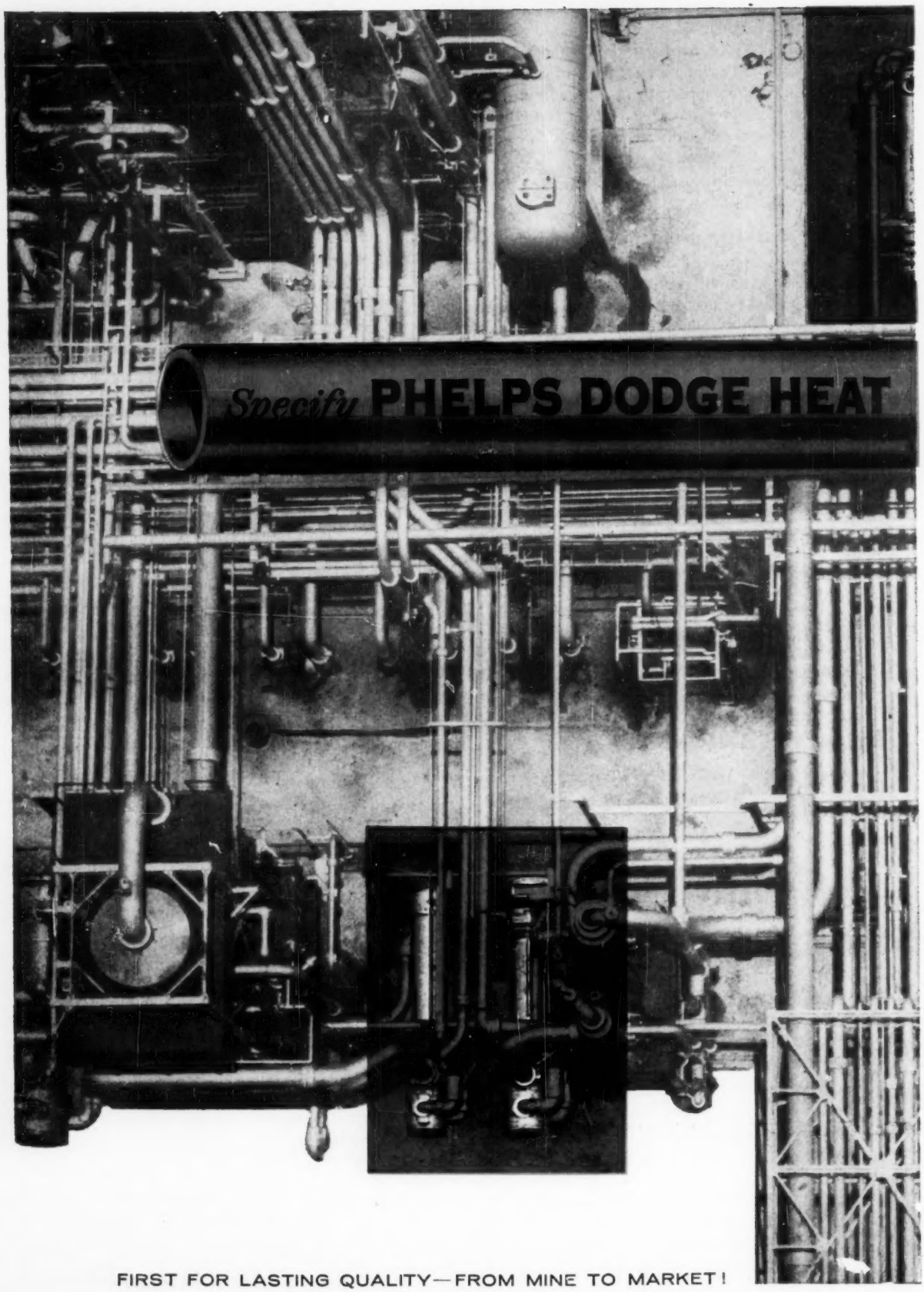


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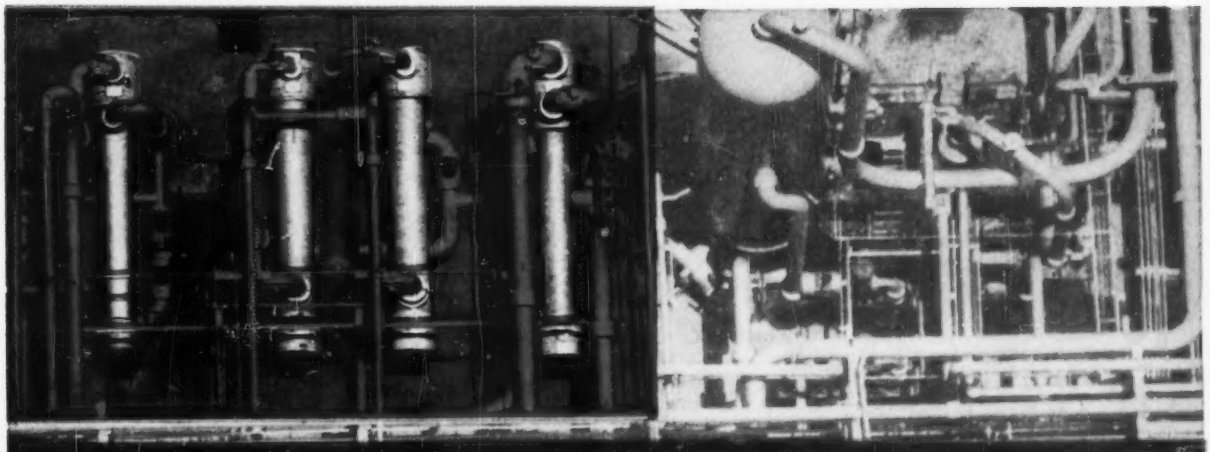

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- Full range of copper-base alloys for every application.
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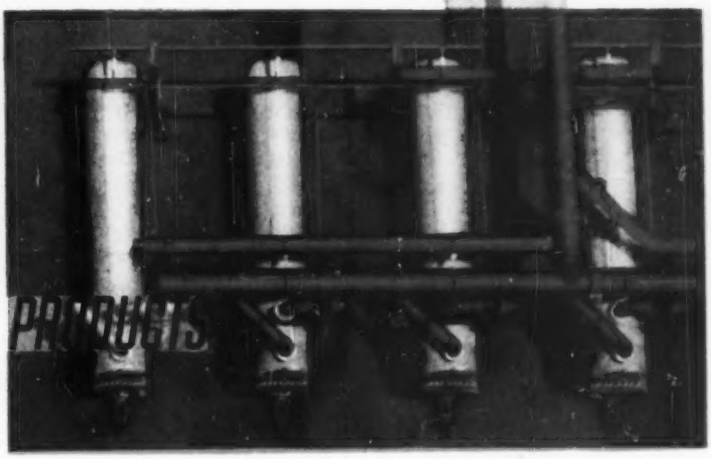
MINE TO MARKET



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# How large can a Packed Column be ?

Up until a relatively few years ago packed columns in excess of 8 feet to 10 feet in diameter were generally restricted to specific operations such as gas drying or water cooling. In liquid-liquid extraction, in distillation, diameters of packed columns beyond 4 feet were considered impractical and uneconomical.

Today, due to the development of more efficient tower packings (such as Intalox Saddles and metal Pall Rings) and more effective methods of distribution, there is virtually no limit to the diameter of an efficient packed column.

We know of two towers 53 feet in diameter with packed beds 26 feet deep. Scrubbing towers 25 feet or more in diameter are becoming quite common. And in distillation operations where perforated trays or bubble caps had been almost universally specified for columns larger than 4 feet, packed columns 10 feet to 12 feet or more in diameter are being used with increasing frequency.

In operations involving Absorption, Stripping, Cooling, Fractionation, Distillation or Liquid-Liquid Extraction, the packed column offers greater efficiency at lower installation and operating costs in virtually any size.

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*Designers, Engineers and Manufacturers of Metal and Ceramic Towers, Tower Accessories, and Tower Packings.*

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**For dependable security at low operating cost in hazardous locations . . .**

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The longer life of mercury vapor lamps is well established: 7000 hours, *vs.* 1000 hours for incandescents. Light output is 2.5 times greater; 55 lumens/watt, *vs.* 22 lumens/watt for incandescents.

The new EV's place these economies within easy reach. As with all Crouse-Hinds explosion-proof devices, EV's are heavily constructed to withstand the pressure of internal explosions without rupturing. Gas-tightness is *not* a requirement for their safe performance. Flame-tight joints prevent the escape of flames to flammable atmospheres.

- *For full information, call your Crouse-Hinds distributor, or write for catalog sheet.*

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**Available with or without guard, or reflector (dome, deep bowl, shallow bowl, angle, or high bay)**

**250 Watt—** National Electrical Code: Class I, Groups C & D

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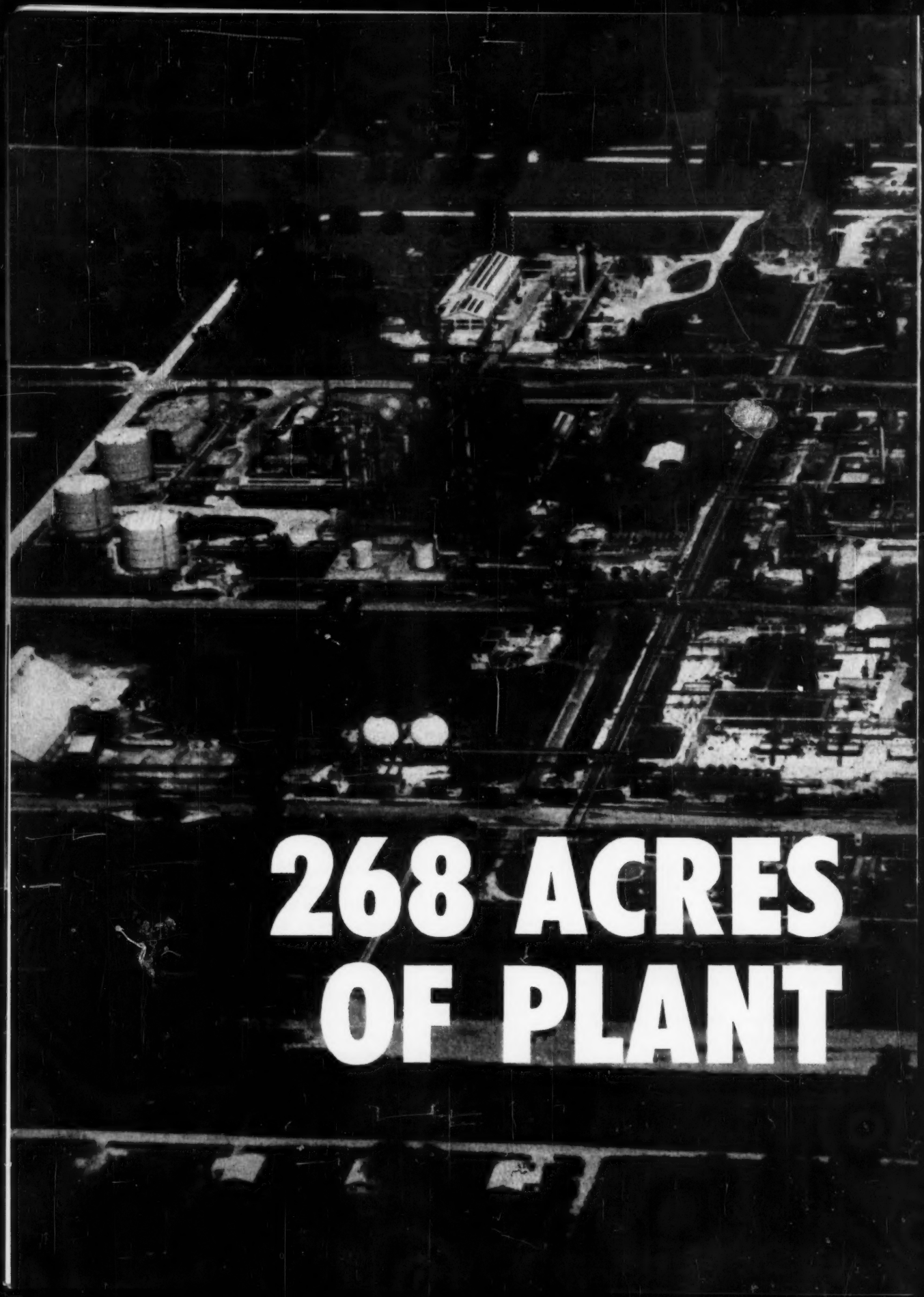
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## "What is past is prologue"

The fifty years behind us embrace an exciting, outstanding era in the development of the oil and gas industry. New, almost unbelievable, technology has revolutionized every phase of our industry.

As we commemorate our Golden Anniversary at Southern Engine & Pump Company, we are proud of being a part of the parade of progress that has meant so much to the Gulf Coast area. Our celebration is actually an observance of gratitude for the experience gained from those eventful years. This experience, rather than signifying a complacent fulfillment, has prepared us for even greater service to the industry that has made our growth and development possible.

Our aim today — as it was a half century ago — is to continue serving our customers with the finest products and service available. Truly, here at Southern Engine & Pump Company, the "past is prologue."

**SOUTHERN ENGINE & PUMP COMPANY**

**MANUFACTURERS · MACHINERY FACTORS · CONTRACTORS**

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# Now...SEPARATE the Risk from Fuel!

600 GPM Jeep-mounted PERMA-DRY Fuel-Water Separator.

## PERMA-DRY... *The only proven unit for JP or RP fuel-water separation*

Developed for the missile, jet and rocket program and proven by rigid Air Force and Government tests, PERMA-DRY *exceeds* Government specifications (600 GPM).

The PERMA-DRY Fuel-Water Separator will break an emulsion from any fuel and deliver it 10 to 15 PPM below the saturation point and sub-micronically clean.

Designed for highest dependability, the PERMA-DRY has been tested successfully more times and in more places than any other separator. Utilizing inexpensive elements, PERMA-DRY is easy to use and maintain. It is available in sizes from 5 to 1500 GPM in either mobile or stationary mountings. Dirt-holding capacity more than double that called for in military specifications insures longer life between servicings of the PERMA-DRY Unit.

Now, the use of a PERMA-DRY unit will assure you of absolute jet fuel reliability . . . give safe, high-speed refueling. PERMA-DRY eliminates "flame-outs" caused by contaminated fuel.

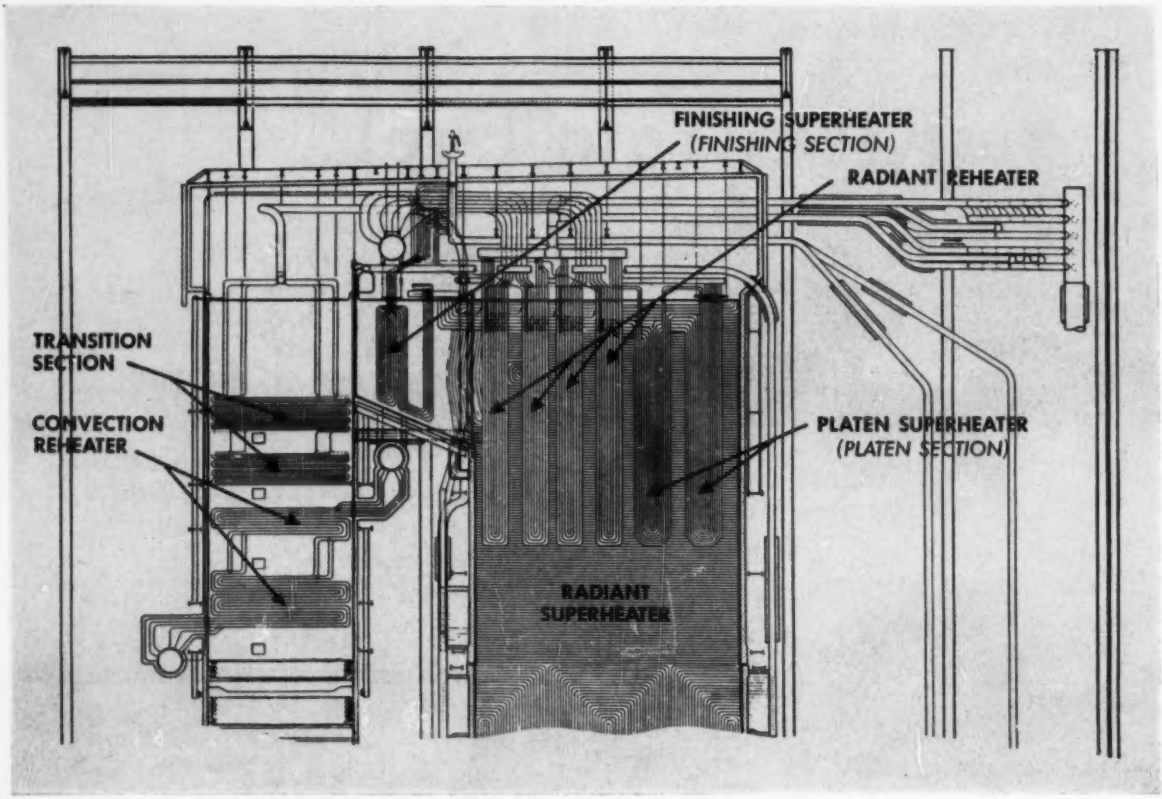
If your present equipment is of the old type, phone or wire the PERMANENT FILTER CORPORATION . . . the world's foremost rocket, missile and aircraft filter manufacturer.

*Reliability is the reason why Permanent Filter Corporation's sales have doubled every year for the past seven years. Over 500 field-tested models of airborne and ground support PERMANENT FILTERS are now being used in more than 100,000 missiles, rockets, and supersonic aircraft.*

A few distributor areas are still open for the world's fastest-growing sales organization.

## PERMANENT FILTER CORPORATION

Address Department PR4, Permanent Filter Corporation, 1800 W. Washington Boulevard, Los Angeles 7, California, for additional information regarding specific filtration requirements you might have. Detailed recommendations furnished on request.




# Philadelphia Electric sets new record for steam pressure-temperature *using Timken® seamless steel tubes*

COMBUSTION ENGINEERING CO., had the job of designing and building a steam generator for a revolutionary new power plant for Philadelphia Electric. They had to harness the highest combination of pressure-temperature ever achieved with steam—5,000 psi and 1,200° F.

This meant superheater tubes made of a special, stronger steel never before used in steam power plants. But no one had ever succeeded in piercing this tougher steel. Combustion Engineering gave the problem to Timken Company metallurgists, experts at piercing special steels for 29 years. And they turned the trick. They made the electric furnace steel with the alloying elements in just the right balance to develop perfect piercing quality. They were able to pierce *20 miles* of tubes free from either surface or internal flaws.

And now you can get Timken® heavy wall seamless tubes up to 11″ O.D. x 3¼″ wall. It's available in all the popular low and intermediate alloy steels and austenitic stainless grades—304, 316, 321, 347 and other special analyses. This gives designers a broad range of high temperature strength together with the required degree of corrosion and oxidation resistance. And delivery is within normal mill lead times.

Because we make our own electric furnace Timken fine alloy steel, you can be sure of accurate analysis—uniform from heat to heat, order to order, tube to tube. If you have a tubing problem, Timken Company metallurgists will gladly help you solve it. The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".

**TIMKEN** *Fine Alloy* **STEEL**

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**SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS STEEL TUBING**



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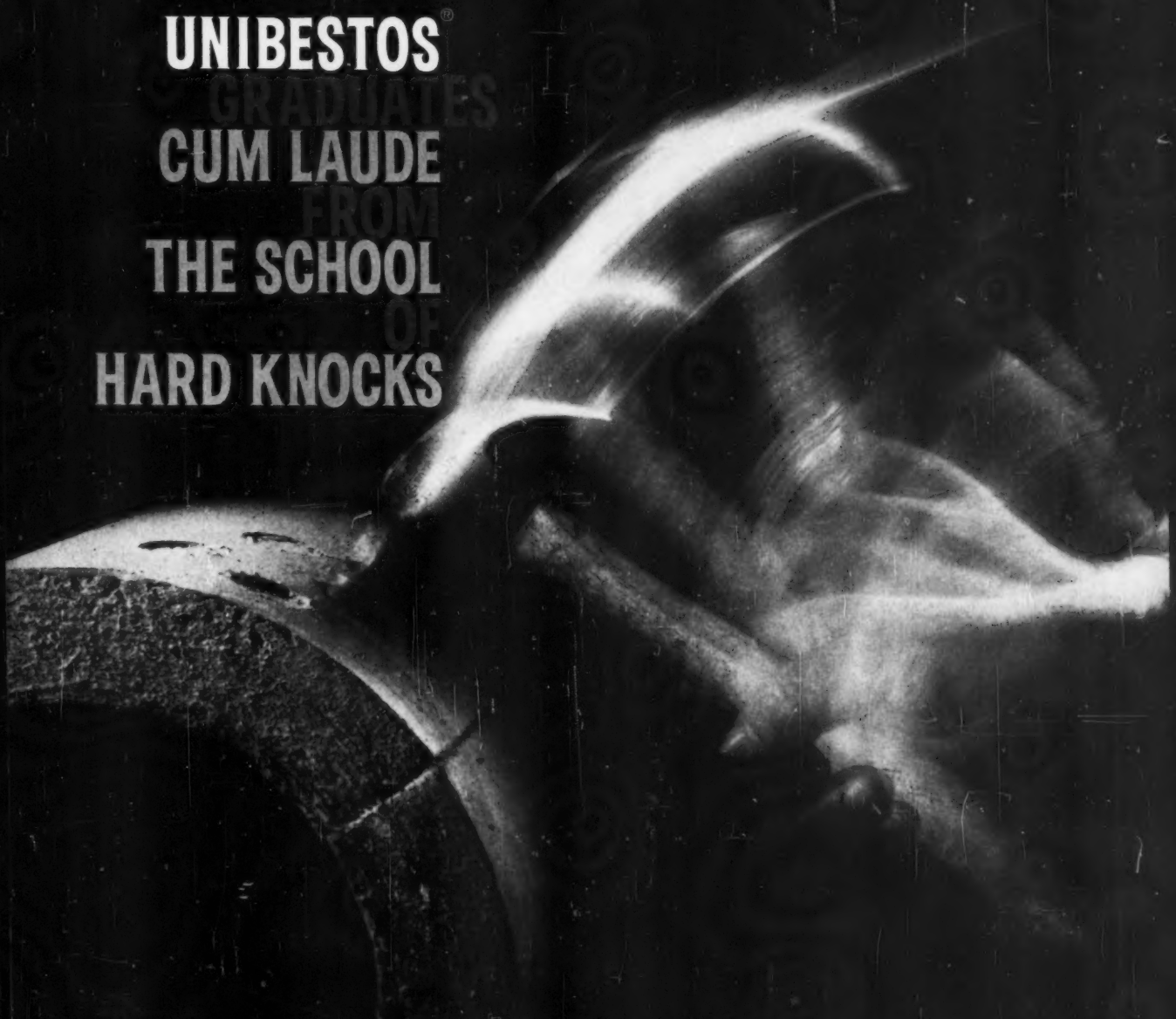

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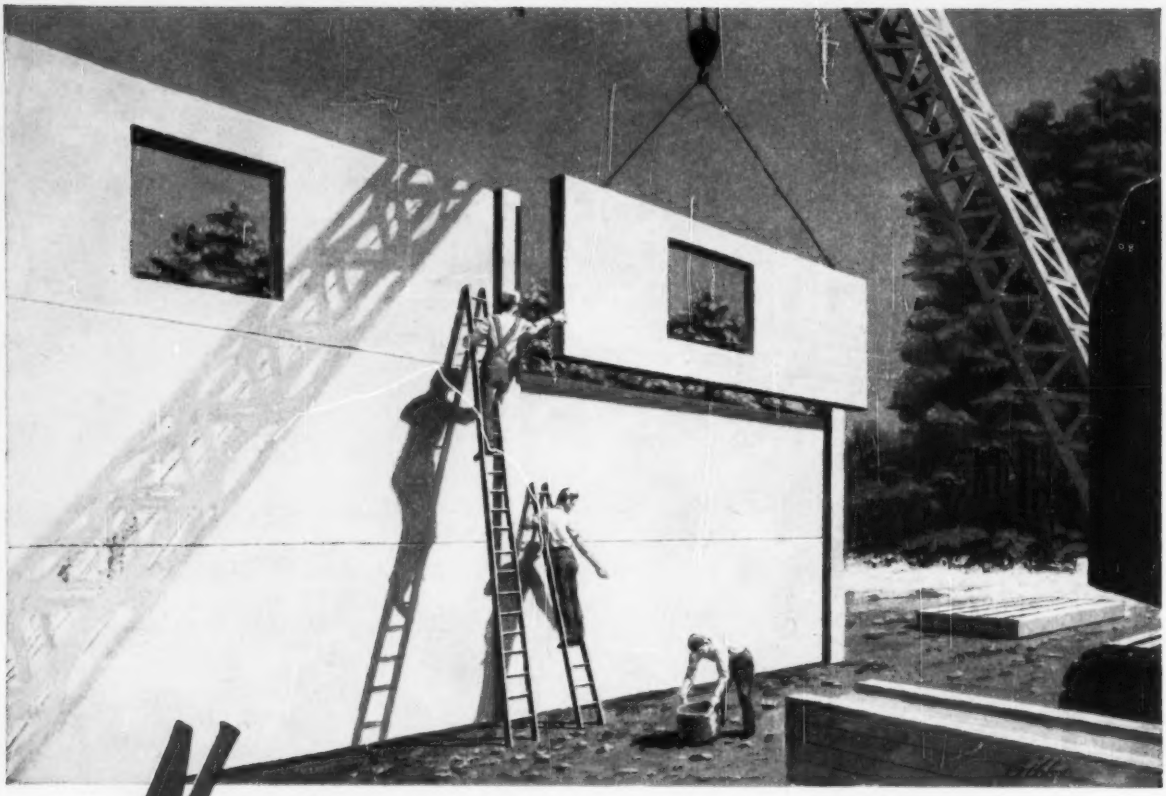


# Now Permanent Concrete Buildings

## *Erected in Hours!*

**DESIGN**—Rackle provides professional assistance in building design and all phases of engineering.

**MANUFACTURE**—4000 to 5000 PSI lightweight Haydite concrete is conventionally reinforced and/or prestressed by Swiss-patented BBR system. Strict production and laboratory control insures positive strength in Rackle members.

**DELIVERY**—Rackle trucks deliver structural components to jobsite as soon as the foundation is poured.

**ERECTION**—Units are put into place as quickly as they are delivered. Columns are set first. Then beams. Finally channel roof deck. Small buildings can be set in 8 hours; a 30,000 sq. ft. warehouse in 40 to 60 hours.

**FINISHING**—Six inch thick pre-cast wall panels with plain or textured surfaces can be installed rapidly, or you can use any other architectural treatment you prefer.

**From design to finished product, Rackle provides a complete concrete building engineered to individual specifications with speed and economy.**

Rackle's new engineering and production technique makes *extra speedy* construction possible with permanent, maintenance-free concrete.

Engineered and cast to individual specifications at our Houston plant, Rackle structural members are trucked to your building site and erected in a matter of hours.

Initial cost is surprisingly low because of speed of construction, and when you build with concrete you continue to save for many years because concrete requires little or no maintenance and insurance rates are lower, too.

**Write or call today for literature on building with Rackle.**

**THE RACKLE COMPANY OF TEXAS**

PO BOX 15008 • HOUSTON • OR 2-1736

*Serving the Texas Gulf Coast Only*

**Manufacturers of quality concrete products since 1870 . . . a wholly owned subsidiary of the Geo-Rackle and Sons Co., Cleveland, Ohio.**



For more data on advertised products, use Readers' Service Cards, last page.

# POTENTIAL

. . . here's *full* potential for oil refineries, chemical and heavy industrial plants, because . . .

FABRICATION . . . of all types of equipment *(Fractionating Columns, Gas Columns, Pressure Vessels, Plate and Heavy Steel Work, Special Machines, Autoclaves, Shells, Base Bridge Girders)* . . . is performed to order . . . to specification.

MACHINING . . . fully equipped, flexible facilities for machining to close tolerances, regardless of product size or design.

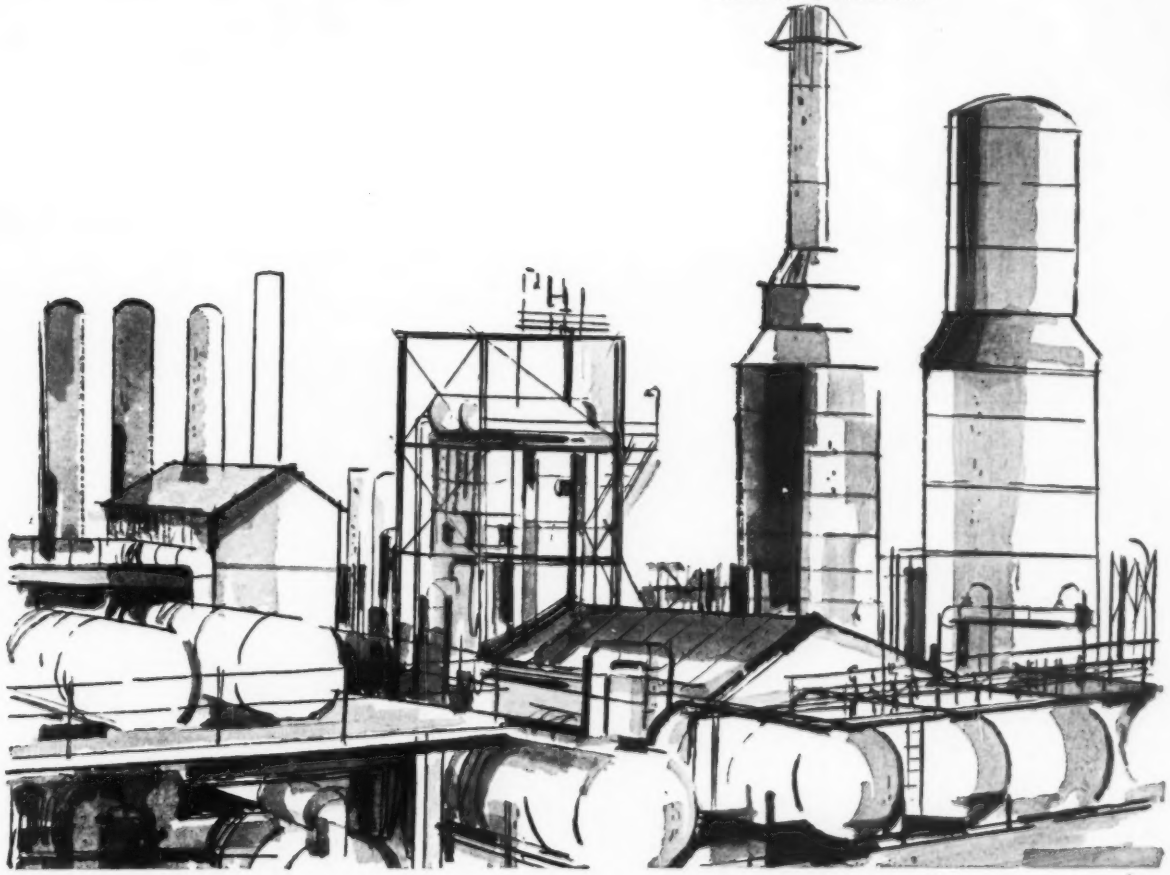
STAINLESS . . . separate, integrated shop for stainless fabrication protects against contamination by ordinary steel.

DELIVERY . . . by rail, truck or inland, coastal or overseas waterway.

Through integrated, efficient operation, Sun Ship can reduce costs . . . increase your POTENTIAL. Call for an estimator or representative.

**SUN SHIP**

BUILDING & DRYDOCK CO.
CHESTER, PENNSYLVANIA





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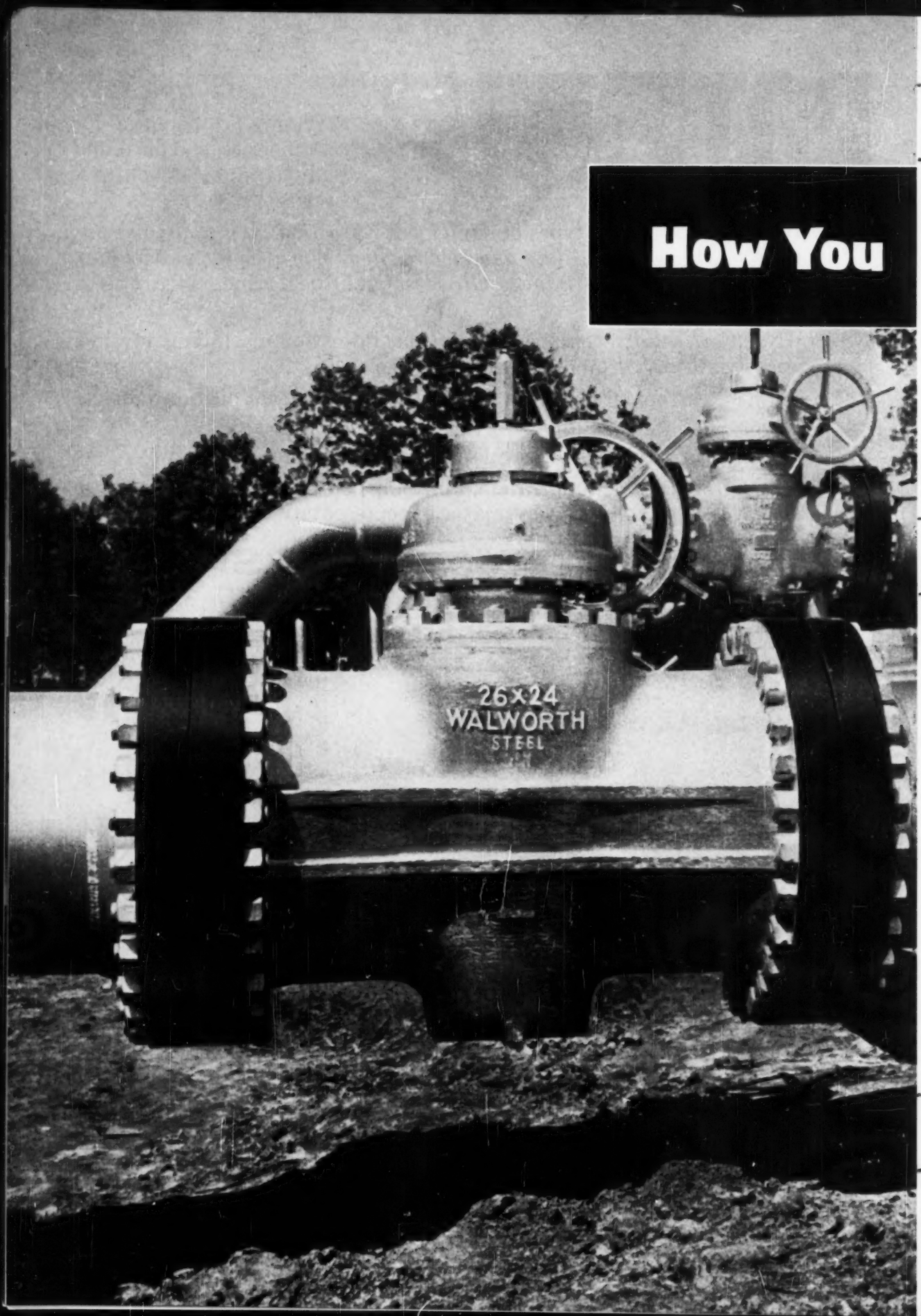
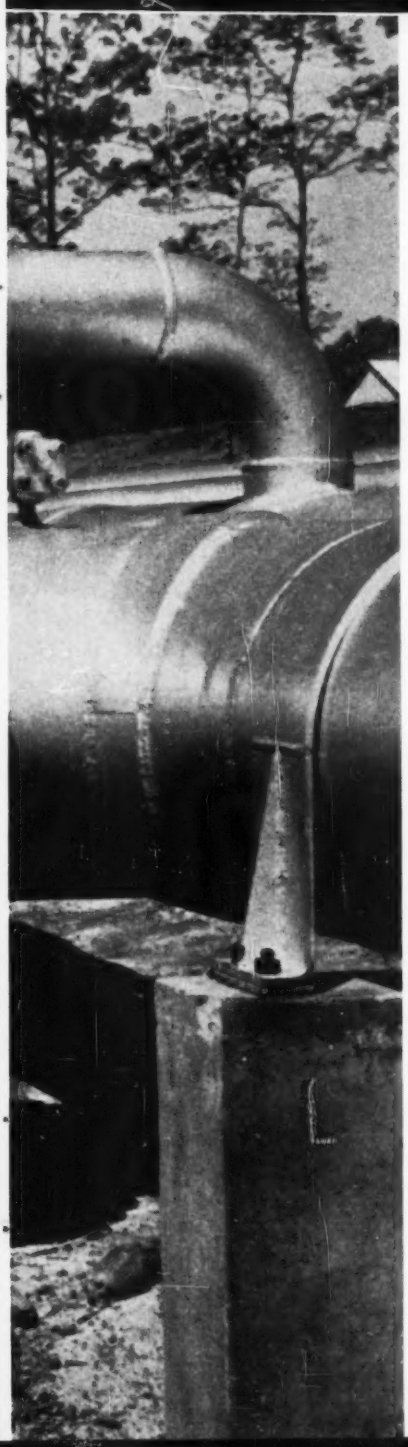

How You
26x24
WALWORTH
STEEL

# Profit With Better Plug Valves



**Walworth Lubricated Plug Valves,** available through Jones & Laughlin Supply Division, will give you better performance with these plus features.

All **Walworth Lubricated Plug Valves** are hydrostatically tested at every position from wide open to fully closed.

Positive open and closed stops and position indicators eliminate the guesswork in your valve operations.

Designed with the adjustments on top, **Walworth Lubricated Plug Valves** are more accessible.

The direct port opening of these valves eliminates flow restrictions.

You can have **Walworth Lubricated Plug Valves** in sizes from ¼" to 30". Walworth technical specialists will gladly assist in your valve engineering.

Call your local Jones & Laughlin Supply Division store or office for complete information on better plug valves.

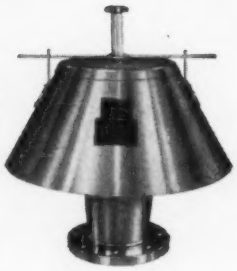
**Jones & Laughlin**

**SUPPLY DIVISION** – Tulsa

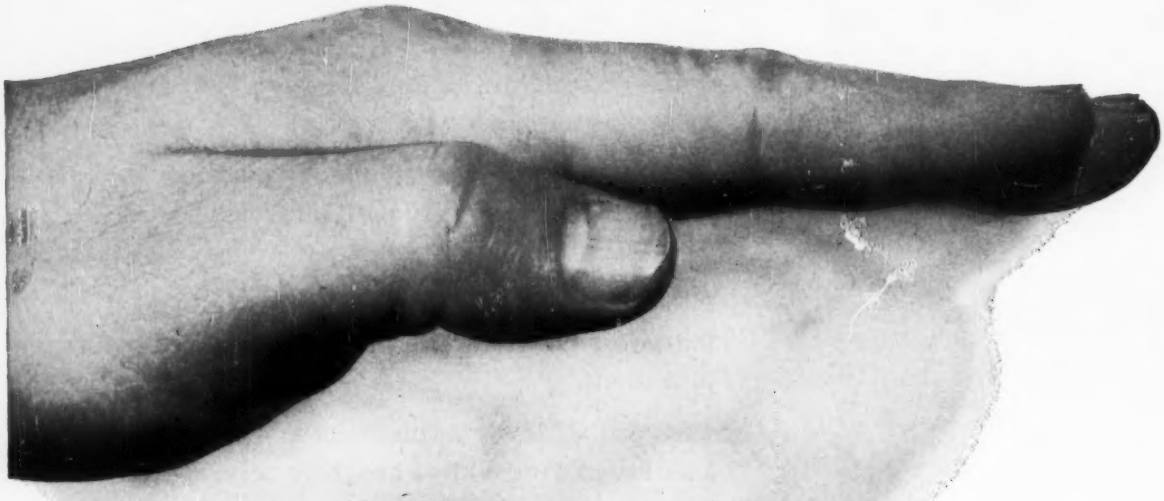
If it's sold by J&L....
It's the best available

68

*new* **S&J** *Breather Valves*



# Materially Reduce Storage Tank Vapor Loss



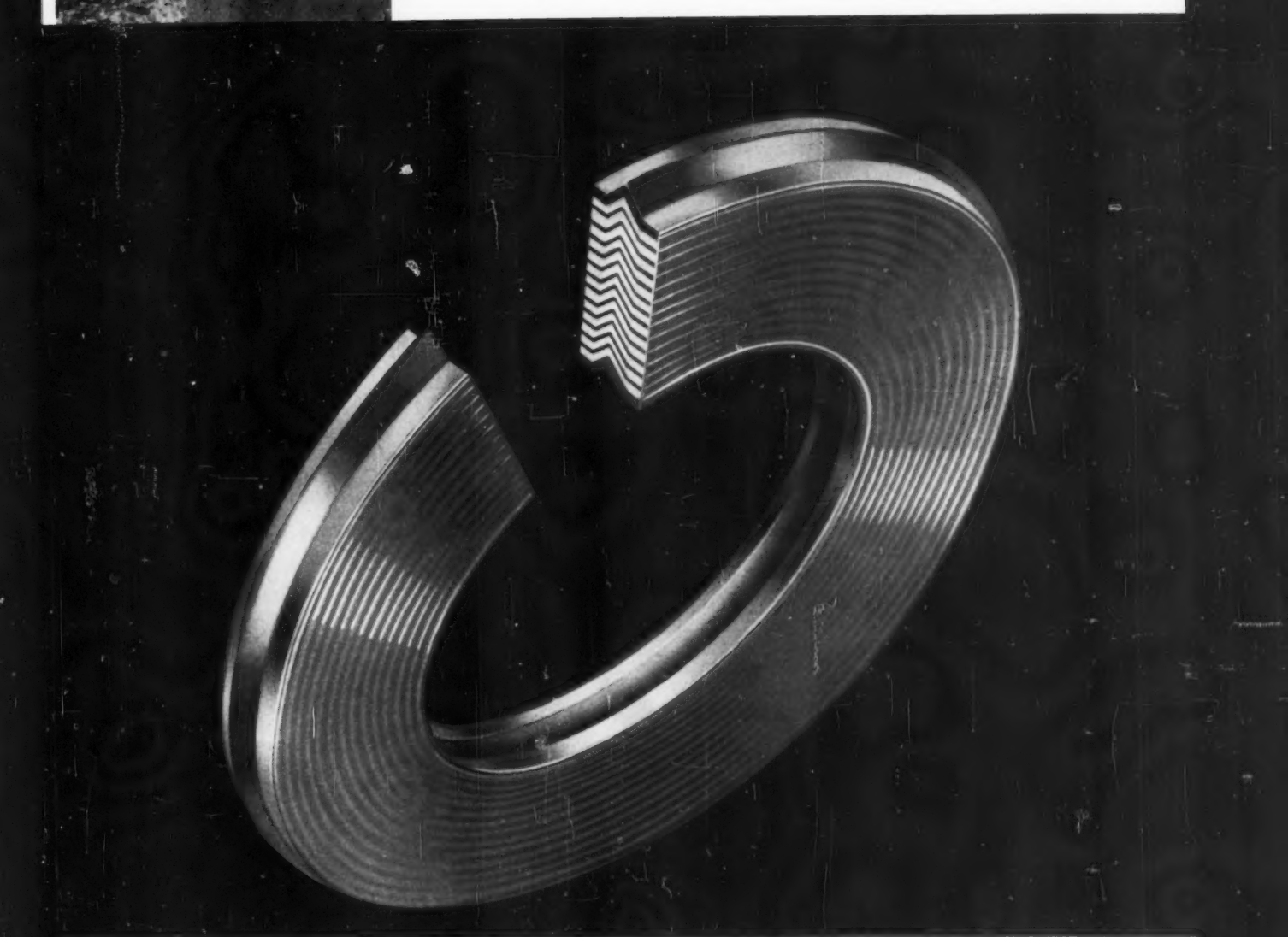
New Shand and Jurs model ST-9749 diaphragm-type breather valves are a major achievement in storage tank venting and vapor conservation. They provide resistance to sticking, corrosion and freezing never before offered. In addition they require practically no maintenance feature non-wetting teflon-on-fiberglas diaphragms for maximum performance and longer life; completely eliminate critical drain holes or other areas that require continuous checking. Ruggedly built from aluminum and stainless steel, ST-9749 breather valves are lightweight, and already available in 4″, 6″, 8″, and 10″ sizes. Call your nearest S&J branch office or sales representative for Technical Bulletin 52D-ST-9749 Breather Valve.

**SHAND AND JURS**

GENERAL PRECISION EQUIPMENT CORPORATION GPE

**2600 Eighth Street, Berkeley, California**
**Branch offices and representatives in principal cities**

A subsidiary of General Precision Equipment Corporation



# Teflon* SPIRAL WOUND GUARDIAN† GASKETS

## for high temperatures and pressures

against steam, oils, gases, liquids, including most chemicals. Constructed of spiral wound strips of "V"-shaped preformed 316 stainless steel alternated with layers of TEFLON. Spring action of V-shaped metal plies provides automatic reaction to compression, internal pressure variations, temperature changes. Provides excellent recovery to accommodate varying service conditions. Available to all ASA standards for pressures to 2500 psi and for temperatures to 450° F with TEFLON (with asbestos filler for temperatures to 1050° F).

GUARDIAN Gaskets are another important part of the Garlock 2,000 . . . two thousand different styles of packings, gaskets, and seals for every need. The only complete line. That's why your Garlock representative can give you unbiased recommendations. Call your Garlock representative, or write for Folder AD-104.

**THE GARLOCK PACKING COMPANY, Palmyra, N. Y.**

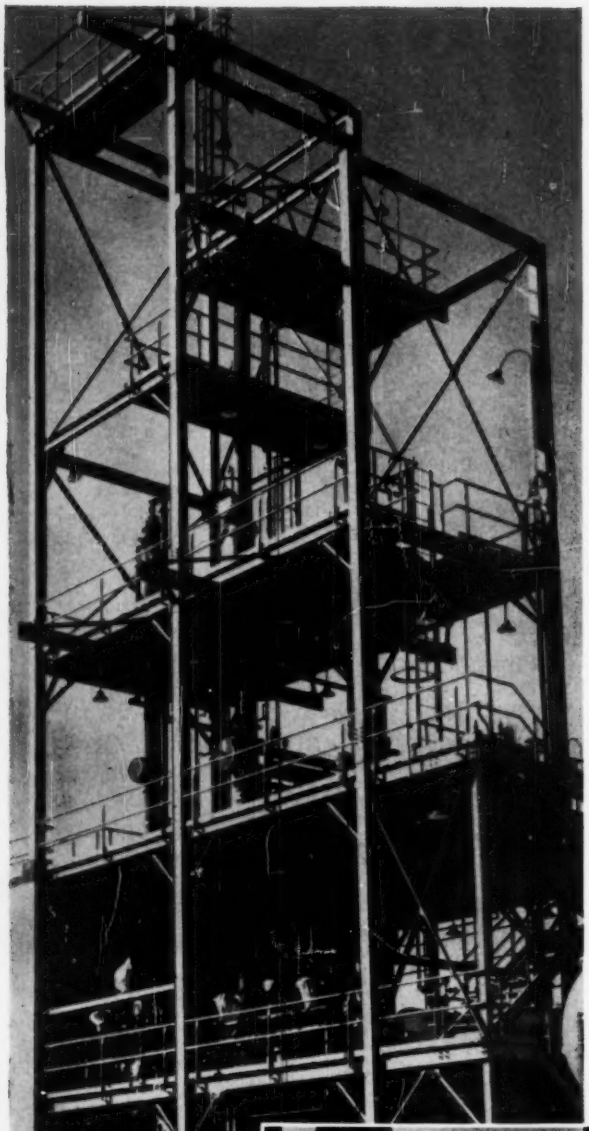
**For Prompt Service,** contact one of our 30 sales offices and warehouses throughout the U.S. and Canada.

GUARDIAN Gaskets are made in round, oval, square, flat side, diamond and pear shapes in practically any size. Thicknesses ⅛", .175", and ¼" depending on application. Centering devices include a steel ring type to assure accurate positioning and to avoid excessive compression. Also, loop type centering guides are available which fit over opposite bolts.

GARLOCK

*Packings, Gaskets, Oil Seals, Mechanical Seals, Molded and Extruded Rubber, Plastic Products*

*Dupont Trademark †Garlock Trademark



*New*

# CHROMOMAX*

## *helps Pennsalt boost product quality*

For more than six months, Pennsalt Chemicals Corporation at Calvert City, Ky. has based control of its Isotron plant on Chromomax data. Component concentrations as low as 0.01% are detected and measured by this highly sensitive L&N Chromomax Gas Chromatography Analyzer. It enables Pennsalt's operator to monitor impurity levels every 10 minutes . . . to make any necessary control adjustments. The result: the refrigerants and aerosol propellents produced have a purity of more than 99%.

Pennsalt also relies on Chromomax because it's dependable . . . needs only routine maintenance . . . requires simply a weekly check against a standard sample. The instrument maintenance group finds that programming cycles are easy to reset after a process changeover. These benefits confirm Pennsalt's policy of getting the best instrument for the application.

If you, too, have a process stream measuring problem, let L&N's versatile Chromomax Analyzer solve it . . . economically . . . dependably. If required, your Chromomax can be equipped with dual column switching or electronic integration.

Check with your nearest L&N Office for application details or write to Leeds & Northrup Company, 4923 Stenton Ave., Phila. 44, Pa. for information.

**Trademark*

In the control room of Pennsalt's Isotron plant, a process operator checks component variations on a Chromomax Analyzer as a guide to resetting control points.

LEEDS NORTHRUP
Instruments Automatic Controls • Furnaces



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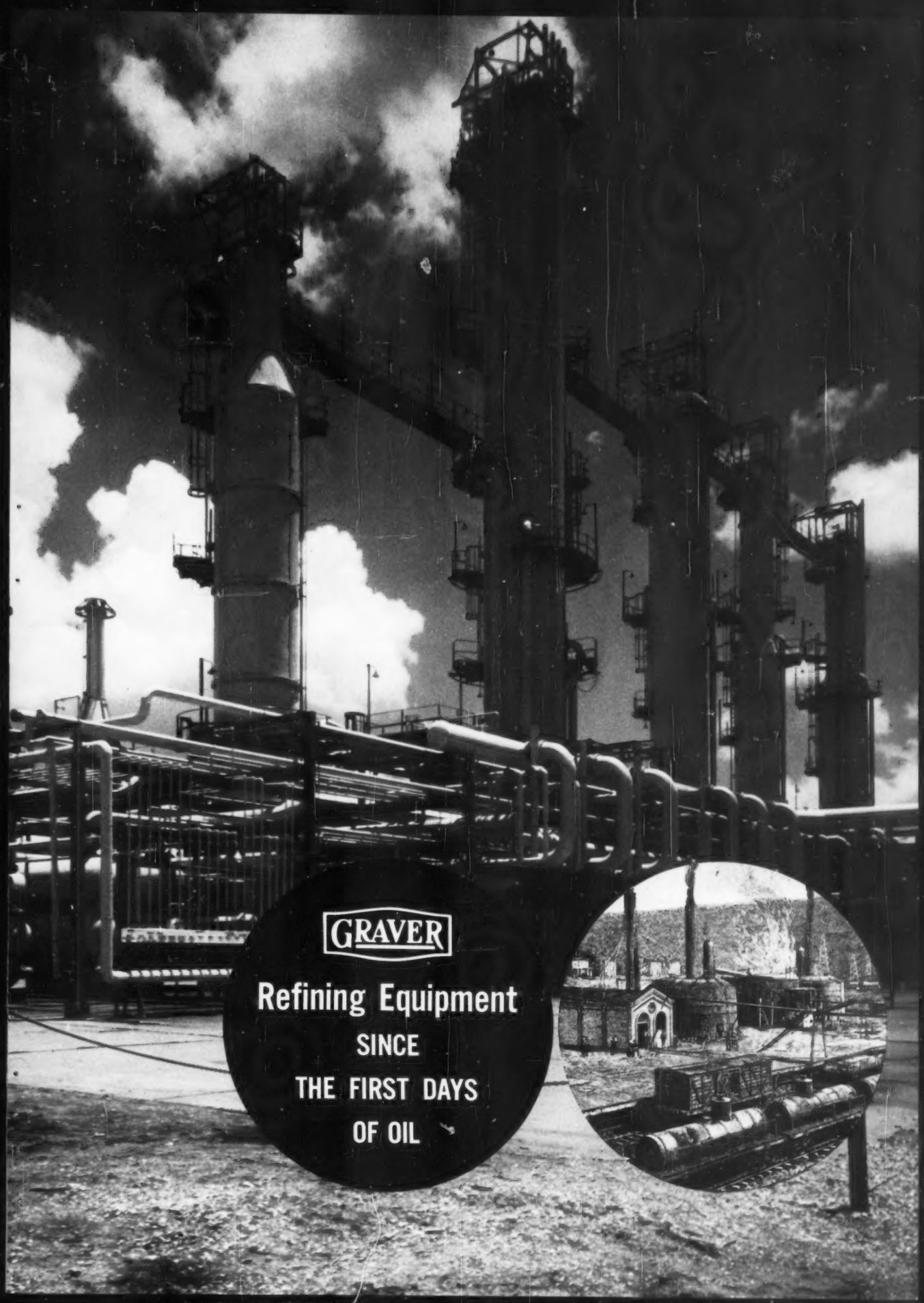
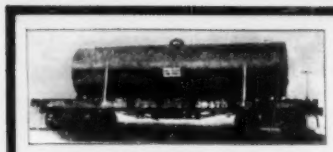

GRAVER
Refining Equipment
SINCE
THE FIRST DAYS
OF OIL

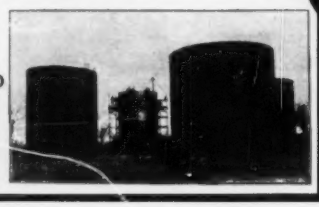


Steel Storage Tanks

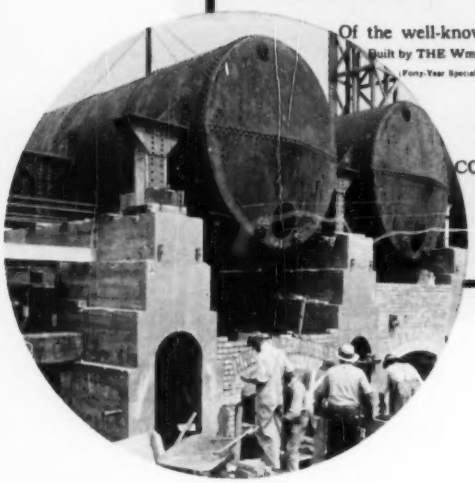
TANK CARS—CAR TANKS
COMPLETE OIL REFINERIES

Of the well-known "GRAVER" quality
Built by THE Wm. GRAVER TANK WORKS
(Forty-Year Specialists in this particular line of work)

CO



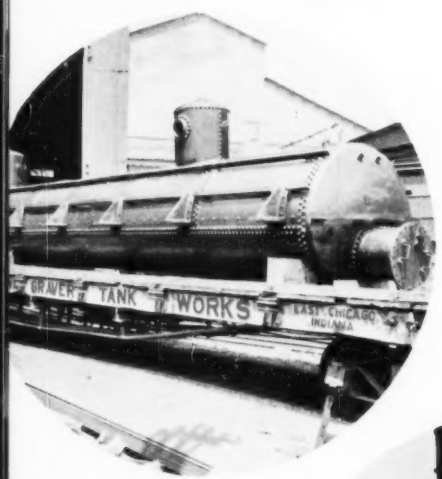
ABOUT 1864—REFINERY NEAR TITUSVILLE, PA.



1917—TWO OF A BATTERY OF 20 STILLS

## PARTNERS IN PROGRESS FOR 100 YEARS

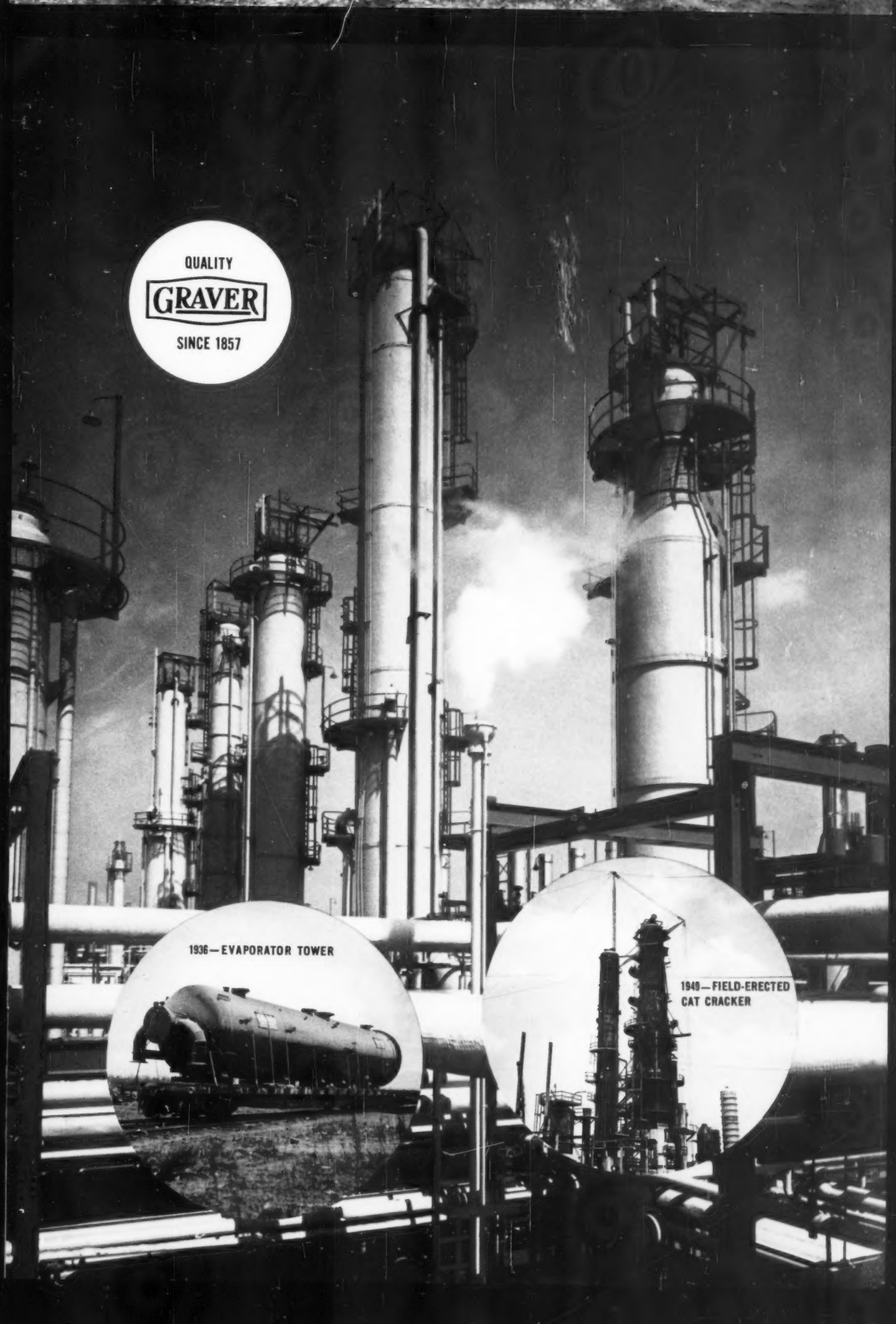
Since the early days of oil, Graver has fabricated and erected refining equipment with the skill and understanding born of a satisfying, century-long association with the dynamic petroleum industry. This 100-year association has enabled Graver to anticipate the fabricating techniques required for the ever-increasing complexity of the processing equipment and pressure vessels needed for more efficient production of consistently higher quality products. Many of the fabricating and welding techniques now commonly used were pioneered or perfected by Graver. Highlighted on these pages are a few of the types of refining equipment Graver has fabricated over the years. Other custom fabrications typical of Graver's other services today in steels and alloys are shown on the back page. Stronger and more diversified, Graver stands ready to serve the petroleum industry with the skill and craftsmanship that has been Graver's accepted trademark for a full century.




1919—SPECIAL ELLIPTICAL STILL

1926—TAR PLANT

1924—PORTABLE REFINERY


QUALITY
GRAVER
SINCE 1857
1936—EVAPORATOR TOWER
1940—FIELD-ERECTED
CAT CRACKER

## BUILDING FOR THE FUTURE ON A CENTURY OF CRAFTSMANSHIP IN STEELS AND ALLOYS

The petroleum, petrochemical, chemical, nuclear and countless other industries find a ready answer to their requirements for processing and storage equipment in Graver custom fabrication and conservation tankage. As one of America's largest metal fabricators, Graver's modern facilities across America for both shop and field-erected fabrication assure the quality craftsmanship required. Graver has a special knack for handling the difficult assignments, too. That's why it's a good decision to talk it over with Graver when you want it fabricated in steels and alloys.

**GRAVER TANK & MFG. CO., INC.** EAST CHICAGO, IND. • PLANTS AND OFFICES ACROSS AMERICA

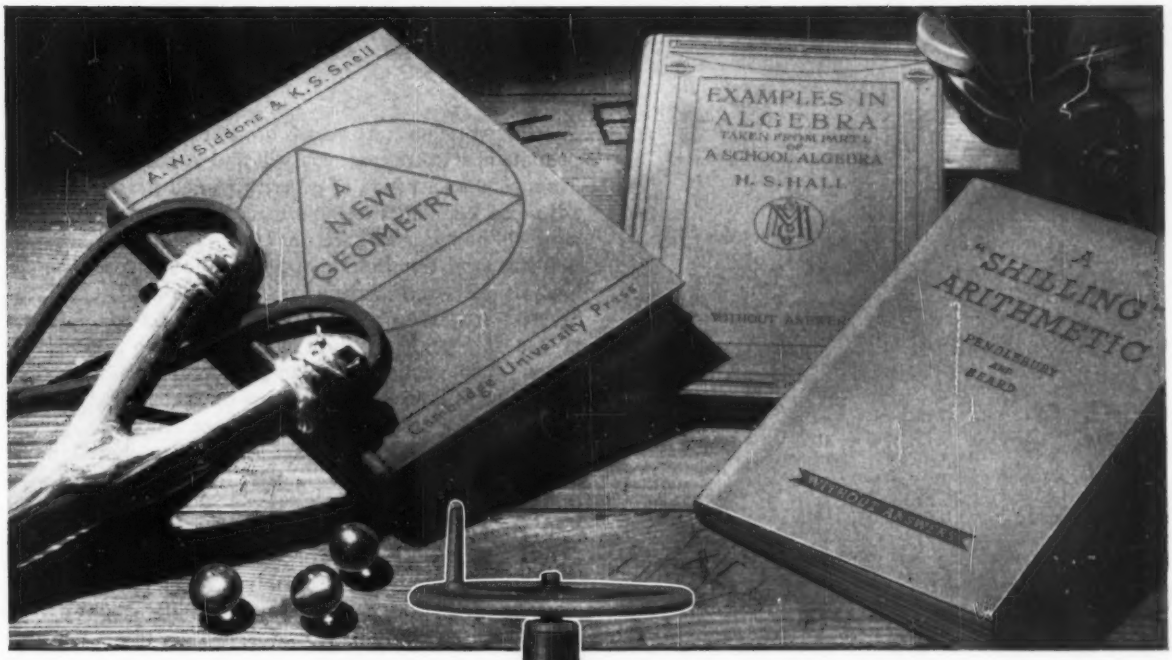
**DIVISION UNION TANK CAR COMPANY**

New York • Philadelphia • Edge Moor, Delaware • Pittsburgh • Atlanta • Detroit • Chicago • Tulsa • Sand Springs, Oklahoma • Houston • New Orleans • Los Angeles • Fontana, California • San Francisco • Seattle • Caracas, Venezuela

Affiliates: The Lang Company, Salt Lake City • Sparling Tank & Mfg. Co., Toronto

Printed in U.S.A.

# Old problems...


A. W. Siddons & K. S. Snell
A NEW GEOMETRY
Cambridge University Press
EXAMPLES IN ALGEBRA
TAKEN FROM PART I OF A SCHOOL ALGEBRA
H. S. HALL
A "SHILLING" ARITHMETIC
PENDLEBURY AND BEARD

# new answers!

The new Triangle Wellhead Valve is one of the latest additions to an ever increasing range of some of the most advanced valve designs available. It is specially constructed to withstand tremendous pressures of up to 5,000 pounds per square inch.

*Full technical details and specifications from:*

**TRIANGLE VALVE CO. LTD.**

CANBERRA HOUSE, 315-7 REGENT ST. W.1. Tel: LANGHAM 6526-7-8 Cables: Trivalon London Telex: 24.100

*Works:* Lamberhead Green, Wigan, Lancs, England. Tel: Wigan 82631 Cables: Trivalve Wigan Telex: 67-539

*Agents in:* Holland · Belgium · Italy · W.Germany · Canada · Australia · Pakistan · Eire · Venezuela · France · Poland · Sweden · Finland · Norway



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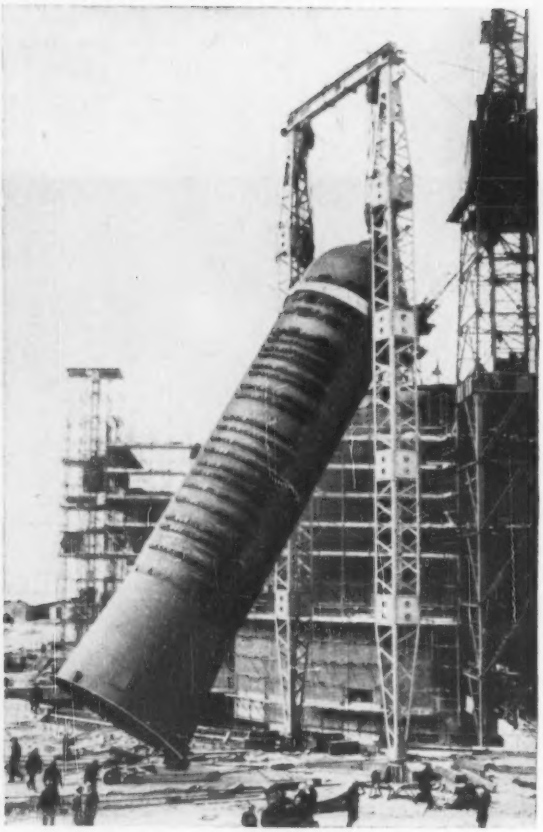


*One of sixteen heat exchange vessels, 82 ft. high, 17½ ft. diameter, 133 tons, Class 1, made in sections at Wolverhampton and welded together on site at Berkeley nuclear power station.*

# HERE IS GREATER FREEDOM FOR VESSEL DESIGN

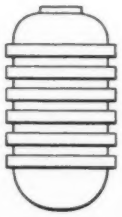
Whether your pressure vessels are to be conventional or quite new in concept, you will find at John Thompson a vast fund of experience* and the most advanced techniques to build them.

You will find you have freedom to think afresh about unit-size limitations and about fabrication in special analysis steels and corrosion resistant linings.

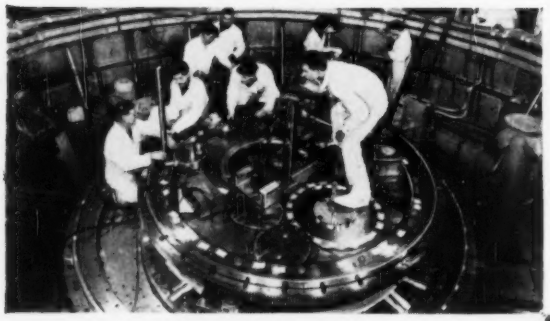
The size of vessel manufactured at the works is limited only by the question of transportation to site. Beyond that size the vessel can be made in sections at the works, then welded together on site. John Thompson are doing this with 1,000 ton reactor vessels of 3 inch thick steel, and with 133 ton heat exchange vessels 17½ ft. in diameter for nuclear power stations.

Here is another development you could use, too—Cylindrical vessels, more economically made than spheres, and more accommodating in shape for many uses, can be reinforced by layers of 'banding'. John Thompson have developed techniques to do this 'banding' on big vessels on site as well as on smaller high pressure vessels in the works.

*John Thompson were pioneers of fusion welding in Britain more than 22 years ago. They have led ever since. They produced the first vessels in Britain in Inconel, Monel, Nickel-clad, and Hastelloy lined. They are continually developing techniques for welded fabrication in special metals.



*BANDED VESSELS*



*Most complicated vessel in the world, 45 tons stainless steel, with rotating end shields and complex tubes, accurate to thousandths of an inch, for Dounreay fast reactor.*

*Stainless steel vessel, 77 ft. long, for a petrol refinery.*

JOHN THOMPSON GROUP

**JOHN THOMPSON (WOLVERHAMPTON) LTD WOLVERHAMPTON ENGLAND**
**JOHN THOMPSON (DUDLEY) LIMITED DUDLEY WORCESTERSHIRE ENGLAND**

DW/2



For more data on advertised products, use Readers' Service Cards, last page.

*"Let's do an abstract," said the artist*
*for the hundredth time.*
*"You pipe down," we answered, "and let us*
*get on with selling Darlington Insulation."*
**"Pipes!"** *cried the artist. "Now insulated*
*pipes can't help looking abstract.*
*It's the shape they are. Anyway, there's*
*nothing abstract about insulation*
*that cuts heat loss to only 10%. You've*
*said so yourself hundreds of times."*
*So we let him do his abstract*
*and here it is.*

306a

But we forced him to leave room for us to say that you will find Darlington Insulation saving money on pipes of all kinds—pipes for steam, for oil, and for many other basic materials of industry—all over the world. Our telephone number, if you'd like to know more, is NEWCASTLE 23666.

THE **DARLINGTON INSULATION** CO LTD

38 GREAT NORTH ROAD, NEWCASTLE UPON TYNE, 2

*Branch Offices in LONDON, BIRMINGHAM, BOLTON, BRISTOL, CARDIFF, GLASGOW, LEICESTER AND SHEFFIELD*

A MEMBER OF THE DARLINGTON GROUP OF COMPANIES



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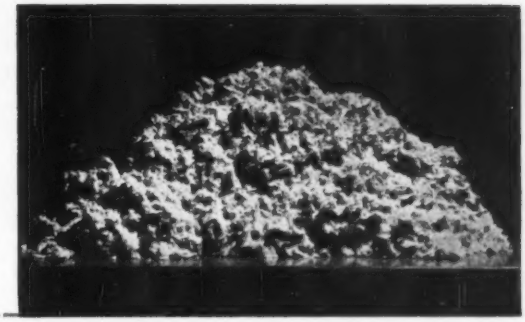
CAPE

# Refinery Insulation

All CAPOSITE moulded insulation materials are made of Amosite asbestos. The photograph clearly demonstrates the immense volume which is obtained when the natural Amosite is fiberised—the sign of high efficiency as an insulating medium.



CAPOSITE is supremely well suited to the thermal insulation of oil refineries. With a limiting temperature of 1000°F., high thermal efficiency and great structural strength and resilience, CAPOSITE has gained for itself a unique position among thermal insulation materials used by the Oil Industry.

**CAPOSITE MOULDED ASBESTOS FIBRE PIPE INSULATION**

EFFICIENCY DATA SHEET—PIPE SIZES 6" to 10" BORE.

| HOT FACE TEMPERATURE °F. | | | 400°F | | | 600°F | | | 800°F | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| THERMAL CONDUCTIVITY K—B.Th.U. in./sq. ft./hr./in./°F. | | | 0.43 | | | 0.47 | | | 0.53 | | |
| MEAN TEMPERATURE °F. | | | 250 | | | 350 | | | 450 | | |
| Nominal Pipe Size | O.D. pipe | Thickness of Insulation | Heat Loss B.Th.U. sq. ft. hr. | Effic. % | Surface Temp. °F. | Heat Loss B.Th.U. sq. ft. hr. | Effic. % | Surface Temp. °F. | Heat Loss B.Th.U. sq. ft. hr. | Effic. % | Surface Temp. °F. |
| 6" | 6⅝" | 1" | 135 | 87·7 | 126 | 233 | 90·6 | 167 | 354 | 92·5 | 218 |
| | | 1½" | 102 | 90·8 | 107 | 177 | 92·9 | 135 | 270 | 94·3 | 171 |
| | | 2" | 83·6 | 92·4 | 97 | 145 | 94·1 | 118 | 223 | 95·3 | 145 |
| | | 2½" | 71·8 | 93·5 | 91 | 125 | 95·0 | 107 | 192 | 96·0 | 128 |
| | | 3" | 63·5 | 94·2 | 86 | 110 | 95·5 | 100 | 170 | 96·4 | 117 |
| | | 3½" | 57·3 | 94·8 | 83 | 100 | 96·0 | 95 | 154 | 96·7 | 109 |
| | | 4" | 52·6 | 95·2 | 81 | 91·7 | 96·3 | 91 | 142 | 97·0 | 103 |
| 8" | 8⅝" | 1" | 130 | 88·0 | 127 | 225 | 90·8 | 169 | 341 | 92·7 | 222 |
| | | 1½" | 97·7 | 91·0 | 108 | 169 | 93·1 | 137 | 258 | 94·5 | 174 |
| | | 2" | 79·2 | 92·7 | 98 | 138 | 94·4 | 120 | 211 | 95·5 | 148 |
| | | 2½" | 67·4 | 93·8 | 92 | 117 | 95·2 | 109 | 180 | 96·1 | 131 |
| | | 3" | 59·2 | 94·6 | 87 | 103 | 95·8 | 102 | 159 | 96·6 | 120 |
| | | 3½" | 53·2 | 95·1 | 84 | 92·7 | 96·2 | 96 | 143 | 96·9 | 111 |
| | | 4" | 48·5 | 95·6 | 82 | 84·6 | 96·5 | 92 | 131 | 97·2 | 105 |

*These figures are compiled from results of official tests by THE NATIONAL PHYSICAL LABORATORY, TEDDINGTON, computed in accordance with formulae shown in BRITISH STANDARD SPECIFICATION appendices.*

*Please write for full technical details*

**THE CAPE ASBESTOS COMPANY LIMITED**
114 & 116 Park Street, London, W.1.
*Cables:* Incorrupt, London.

**CAPOSITE** REGD
*Amosite Asbestos Blocks and Pipe Sections*

Enquiries in **CANADA** to: **Cape Asbestos (Canada) Ltd., 200 Bloor Street East, Toronto, Ont.**
**U.S.A.: The North American Asbestos Corporation, Board of Trade Building, Chicago, 4, Illinois.**
SOUTH AFRICA: Cape Asbestos South Africa (Pty.) Ltd., P.O. Box 2533, Johannesburg; ITALY: Capamianto S.P.A., via Sant' Antonino 57, Turin.
FRANCE: Isolamiante S.A., 37 Avenue Franklin D. Roosevelt, Paris 8e



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# U.S. CONTRACTORS WITH OFF-SHORE CONTRACTS CAN SAVE REAL MONEY

***by specifying***

## FLOWFORGE

**FORGE-WELDED OPEN STEEL FLOORING**

Plain or Serrated edges
(plain edges illustrated)

**BECAUSE:**

### SPECIFICATION

Flowforge Open Steel Flooring is designed to meet U. S. specifications. Recent Test Reports from the Physical Laboratory Division of the Robert W. Hunt Company, of Chicago, U.S.A. are available for examination. All load figures stated in our literature are guaranteed.

### SERVICE

Large stocks of standard panels, 20 ft. span x 3 ft. wide, are held ready for IMMEDIATE shipment to any part of the world. Delivery schedules for tailor-made panels can be arranged to meet site requirements.

### SAVING

Recent contracts, secured against World competition, testify that Flowforge is not only comparable in quality and service, but is lowest in first cost. Contracts have been received from the U. S. Army Air Force, and many important American Companies.

*FLOWFORGE is approved by: The British Admiralty; Esso Petroleum Company, Ltd.; I.C.I. (Billingham Division); I.C.I. (Alkali Division); Kellogg International Corporation; Shell Tankers Ltd.; Shell Refining Company; George Wimpey & Company Ltd.; Mobil Oil Company Ltd.*

**Fisher & Ludlow Ltd**

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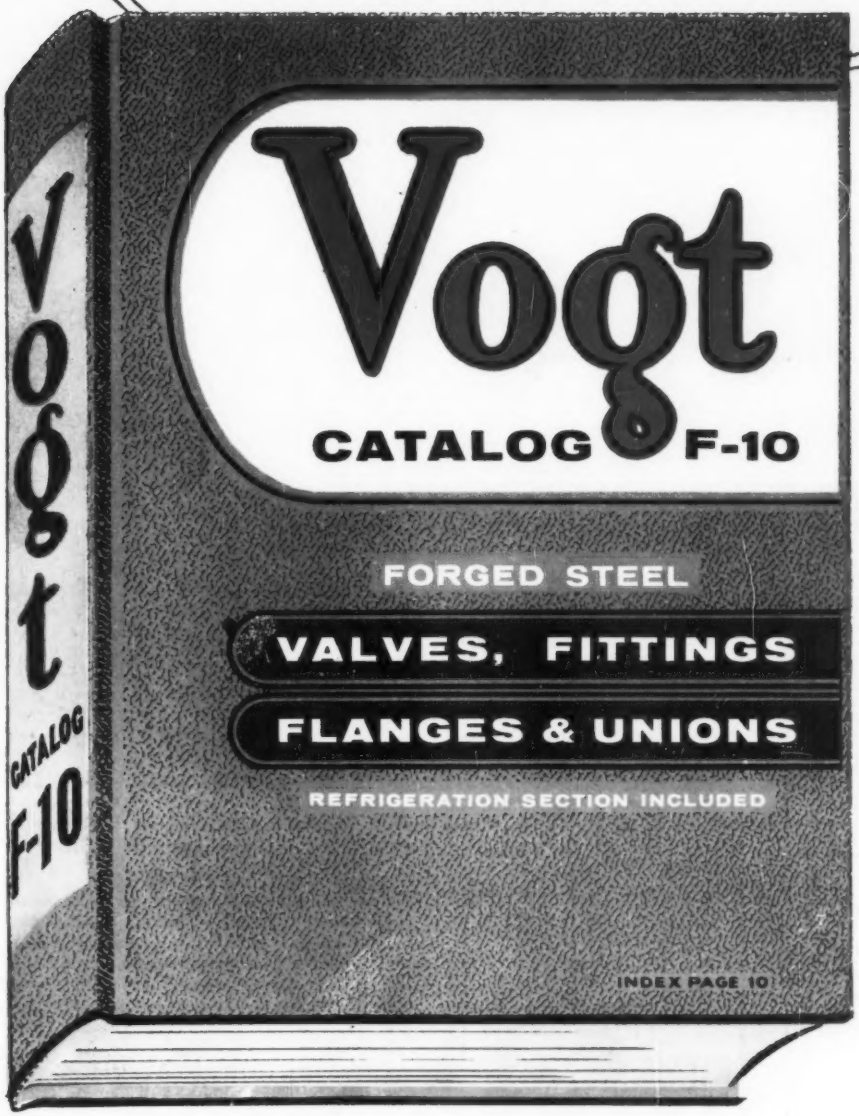

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# Why a Steam Trap Has to Handle "Air"

## Low temperatures and corrosion of equipment are often evidence of inadequate trap air venting capacity

Air, with its load of oxygen and carbon dioxide, has an unwholesome habit of interfering with the efficiency of steam heated units. If steam were always free of these undesirable companions, things would be a lot simpler for men-who-operate-plants. Because it isn't, three unhappy situations frequently occur:

1. ***Operating temperatures are subnormal.*** This is a two-part problem. First, an air-steam mixture has a lower temperature than pure steam at the same pressure—see Table A. Secondly, air can "plate out" on heat transfer surfaces as shown in Figure 1. Under some conditions, such an air film will knock down heat transfer efficiency by as much as 50%.

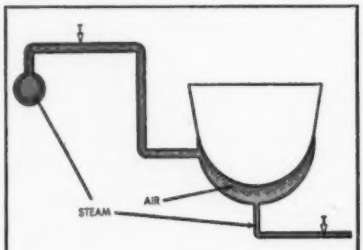



Fig. 1. *How air can "plate out" on heat transfer surfaces. This "insulation" drastically reduces heat transfer efficiency. Armstrong trap operation creates turbulence in the equipment that prevents this.*

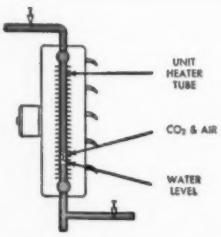



Fig. 2. *Corrosion occurs when units are not kept continuously free of both condensate and air. Armstrong traps discharge both, at steam temperature, as fast as they accumulate.*

2. ***Corrosion rears its ugly head.*** Oxygen and carbon dioxide are real trouble-makers. $CO_2$ gas goes into solution in condensate, forms carbonic acid and chews away at vulnerable metal sections. $O_2$ aggravates the situation. See Figure 2.

**TABLE A—How air reduces steam temperature.**

| Gauge Pressure | Temp. of Steam with No Air Present | Temp. of Steam Mixed With Various Amounts of Air (% Air by Volume) | |
|---|---|---|---|
| | | 10% | 30% |
| 10.3 | 240.1 | 234.3 | 220.9 |
| 25.3 | 267.3 | 261.0 | 246.4 |
| 50.3 | 298.0 | 291.0 | 275.1 |
| 75.3 | 320.3 | 312.9 | 295.9 |
| 100.3 | 338.1 | 330.3 | 312.4 |

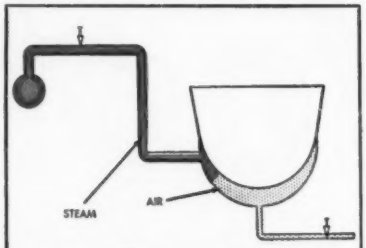



Fig. 3. *When steam is turned on, it takes a trap with extra air venting capacity to provide fast heat-up.*

3. ***Heat-up is slow as a snail.*** Air has a picnic in units that are shut off periodically. Figure 3 pictures the problem. Lines and equipment literally fill up with air. When the steam is turned on it can get in only as fast as the air gets out.

### Enter Steam Traps

Curing these steam system ailments involves an operation sometimes called a "trap transplant." It consists of removing traps that don't get the air out and replacing them with traps that do.

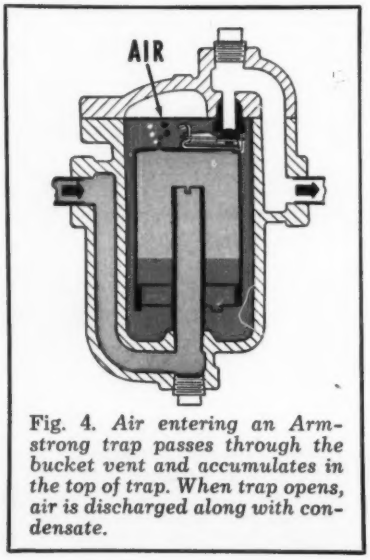
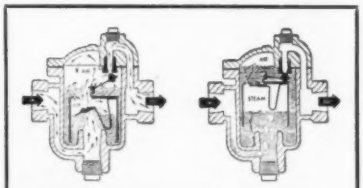



Fig. 4. *Air entering an Armstrong trap passes through the bucket vent and accumulates in the top of trap. When trap opens, air is discharged along with condensate.*

Figure 4 shows how an Armstrong inverted bucket trap continuously vents air. What the picture doesn't show is a built-in plus-value of this trap's design. An Armstrong trap opens suddenly, creating a momentary pressure drop and turbulence in the unit being drained. This breaks up air films and "pumps" air down to the trap so it can be vented.

The vents in standard Armstrong trap buckets will pass all the air normally encountered. In special cases, such as paper machine dryers, the vents are correctly sized larger at the factory to meet the requirement.



*Thermostatic vent open.* *Thermostatic vent closed.*

Fig. 5. *Open float with thermostatic vent for off-and-on units. When trap is cold, vent is open, permitting air to blow through when steam is turned on. When steam reaches trap, heat closes thermostatic vent. Then, regular bucket vent handles all air coming in with steam.*

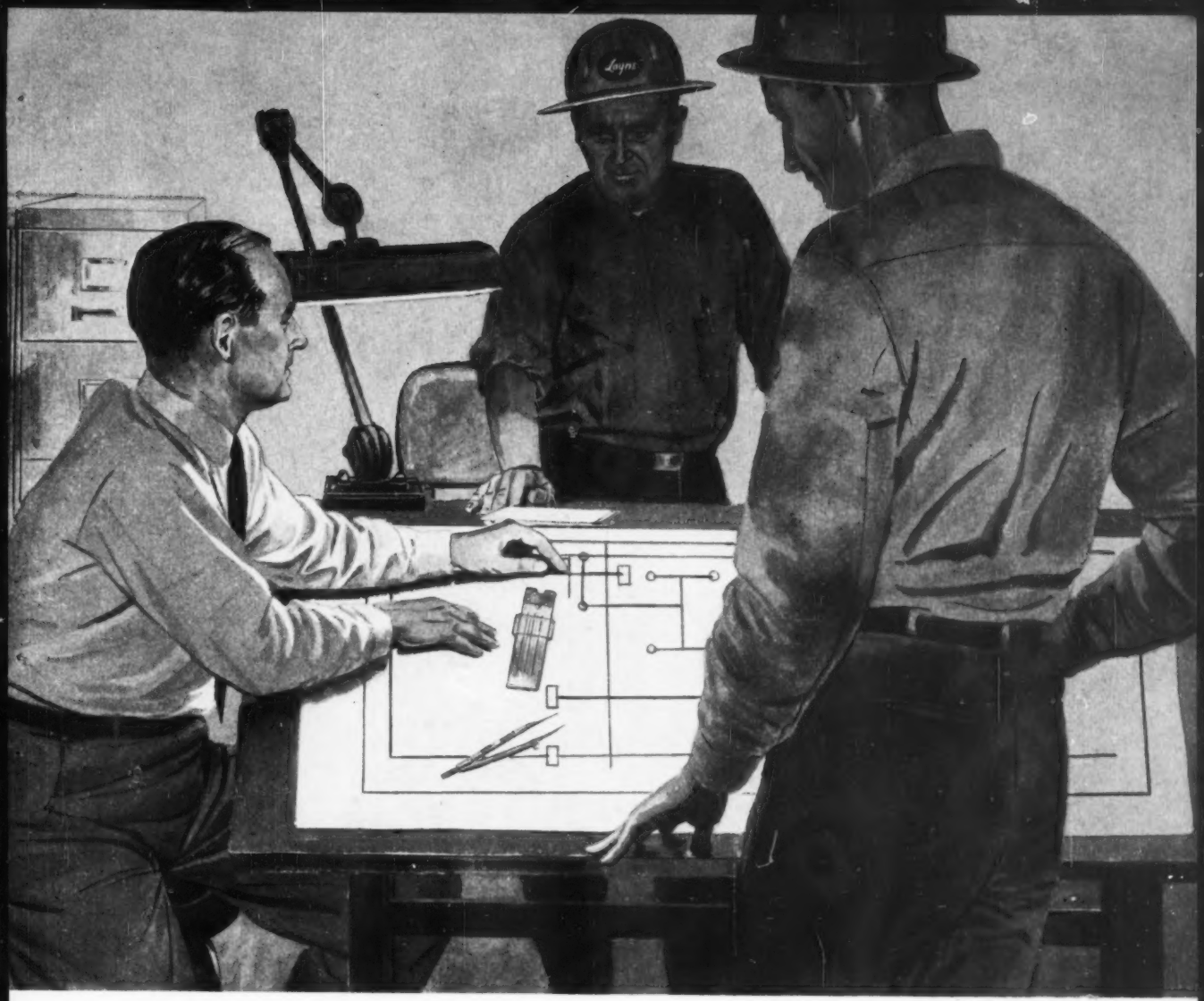
### Open Float with Thermostatic Vent

Super air-venting capacity is a must for fast heat-up of low pressure unit heaters, heating coils, steam headers and other units that are on-and-off. Figure 5 shows how the Armstrong open-float-with-thermostatic-vent trap takes care of this.

* * *

The 44-page Armstrong steam trap book covers other features of the Armstrong trap as well as its excellent air handling characteristics. This catalog also discusses trap selection, installation and maintenance. Your local Armstrong Representative or Distributor will be glad to give you a copy. Call him, or write Armstrong Machine Works, Maple Street, Three Rivers, Michigan.

**ARMSTRONG STEAM TRAPS**



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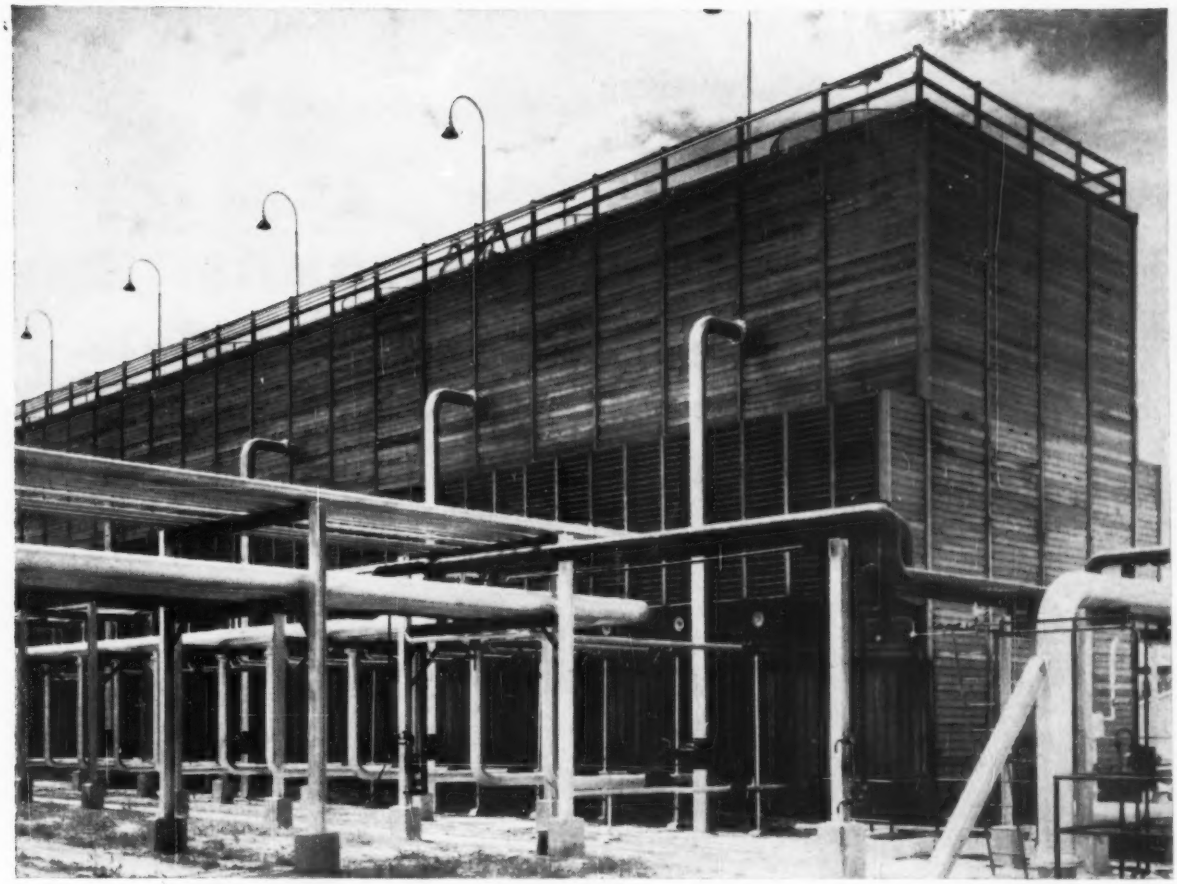

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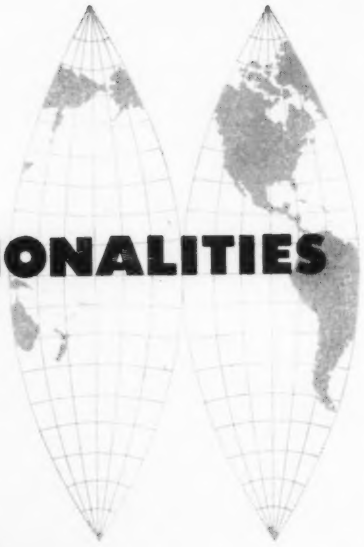

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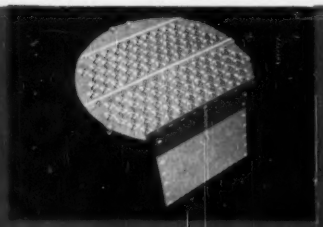

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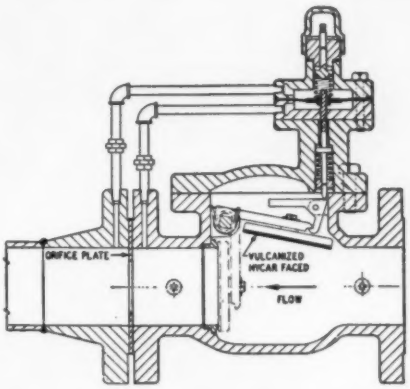
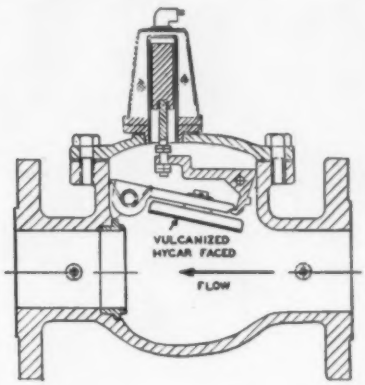
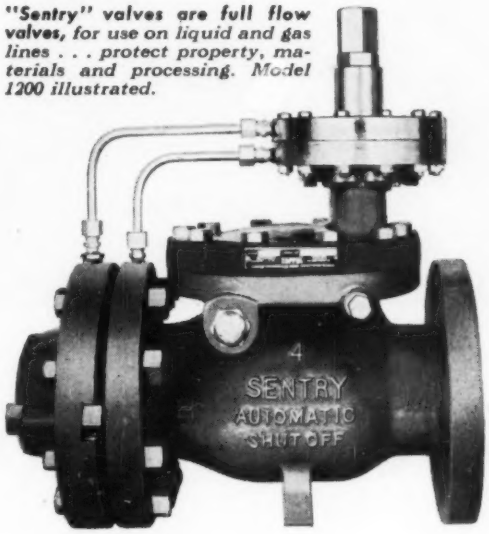



*Model 1200. "Sentry"* **excess flow valve** *automatically and instantaneously shuts off when the rate of flow in the line exceeds a predetermined rate.*

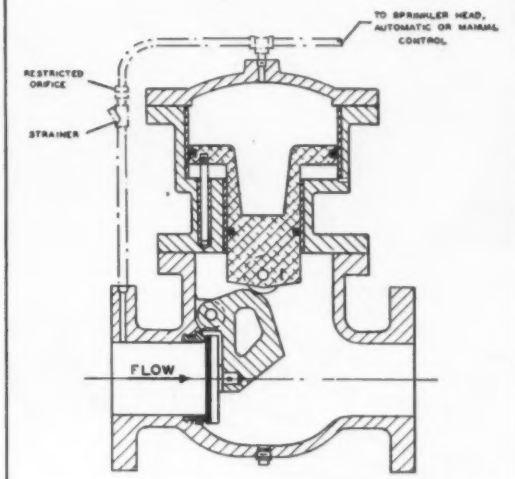



*Models 1700 and 1800 "Sentry"* **solenoid shut-off valves** *operate by remote electrical control automatically and instantaneously. In Model 1700, solenoid is energized, in Model 1800 solenoid is de-energized to maintain flow.*

***"Sentry" valves are full flow valves,*** *for use on liquid and gas lines . . . protect property, materials and processing. Model 1200 illustrated.*




**Other types "Sentry" Valves: high-pressure and low-pressure and over temperature shut-off valves available.**

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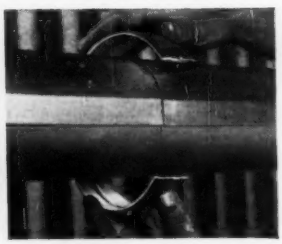
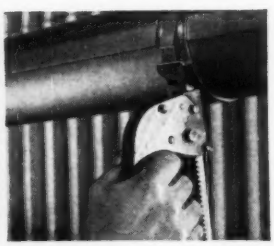


**15 SECONDS LATER** the specially designed aluminum "snap strap" (containing vapor seal) has been snapped on joint.



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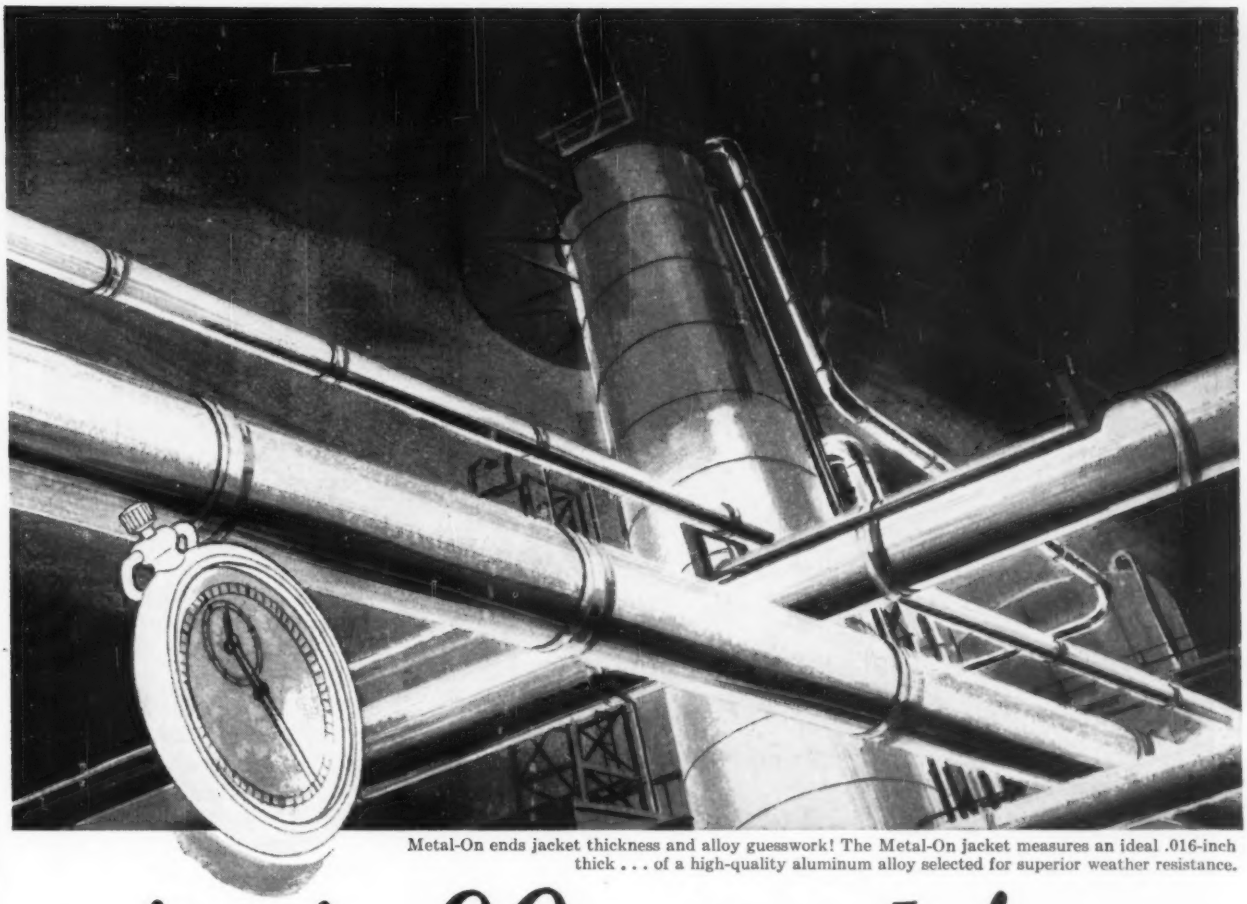

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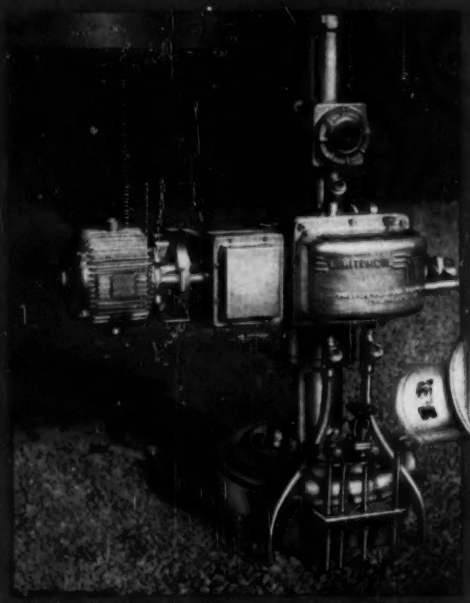

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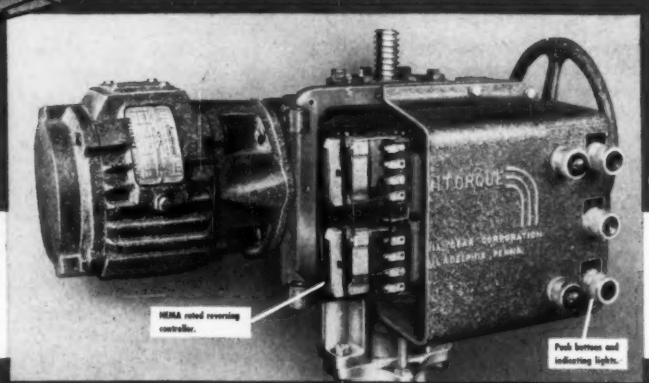


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## *in the electric*

**PETRECO®**

A long list of "firsts" has been added to Petreco achievements since the first electric demulsifying plant was installed for the Lucille Oil Company at Coalinga, California in 1909.

By continuing to carry on a program of progressive development, Petreco has been able to keep pace with the growing needs of the petroleum industry. The electric demulsifier came at a time when the problem of emulsion threatened to cause the waste of millions of barrels of "cut" oil. Then, when salt was recognized as a prime enemy of the refinery, the first electric desalter was developed by Petreco. Petreco was on hand, too, to answer the call for a method of removing sediment from certain crudes when they were found to be shortening the life of sub-surface pumping equipment.

Petreco has also helped in many important ways toward making refinery processing a more exacting science. Petreco electric distillate treating has brought automatic, precision-controlled accuracy to such operations as contacting, scrubbing and washing.

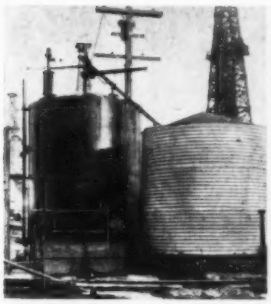
A single-purposed dedication to pioneership in its field, has enabled Petreco to grow by helping the various branches of its industry to better methods, better products and greater operating efficiency . . . with substantial profits as a result. Petreco shall continue to devote its total energies and experience to this program.

*In 1906, Dr. Frederick G. Cottrell of the University of California, perfected a method of precipitating solids from flue gases by subjecting the latter to the forces of a 100,000 volt electric field. In exploring possible uses for the process his attention was called to the tremendous waste in the petroleum industry caused by "useless" oil held in emulsion.*

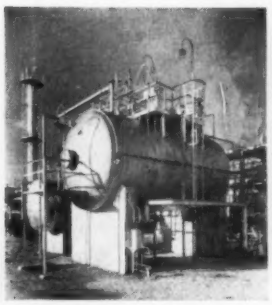
*After a series of extensive tests into the use of the electric field for breaking emulsions, the first commercial installation was set up at the Lucille Oil Co., at Coalinga, California. The plant successfully reduced an emulsion of 14% water to less than 2% at the rate of 1000 barrels a day. The first electric dehydrator had been installed, and Petreco had taken the initial step in leadership based on a long series of "Firsts".*

# 50 YEARS' LEADERSHIP

## *processing of petroleum products*



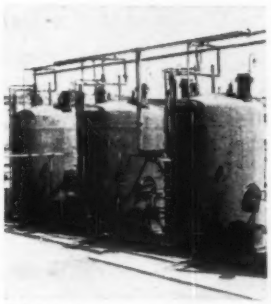
**FIRST*** *Closed Dehydrator*



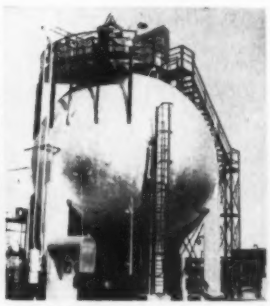
**FIRST** *Horizontal Electric Treating Unit*

**FIRST** *Pressurized Dehydrator*

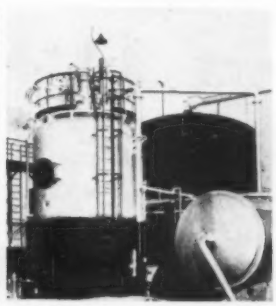
**FIRST** *Flow Line Dehydrator*



**FIRST** *Electric Desalter*

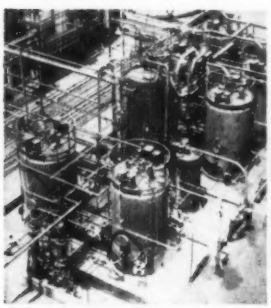


**FIRST** *Spherical Desalter*

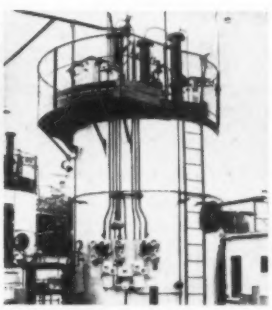


**FIRST** *Electric Distillate Treater*

*Photos used are typical of types of units mentioned. They are not, in every instance, photos of original installations.



**FIRST** *Electric Desaponifier*



**FIRST** *Electric Lube Oil Treater*

**FIRST** *Electric Sediment Separator*

**FIRST** *Two-stage Electric Distillate Treater*

# PETRECO®

A DIVISION OF PETROLITE CORPORATION

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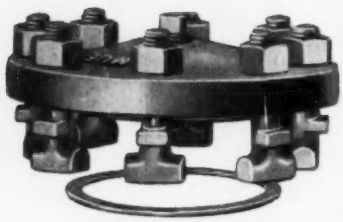
*Specialized Petroleum Treating Processes and Equipment*

PH-58-1

# MUELLER®

## *"NO-BLO® tee gives fast, safe tie-in"*



H-17505 Flanged Tee.
230 p.s.i. working pressure
at 100°F.
Sizes 3", 4", 6", 8".

Tie into steel lines under pressure—without interrupting flow or losing fluid — with the Mueller Flanged Tee. Forged-steel tee has similar analysis to pipe line, assuring easy weldability on inlet and outlet. 150, 300, 400 and 600-pound flanges withstand operating pressures up to 1200 p.s.i. Tee can be installed under operating pressures up to 500 p.s.i. at 100° Fahrenheit or 250 p.s.i. at 500° Fahrenheit with the Mueller power-operated C-1 Drilling Machine.

Cut into the line is made through the tee with Mueller equipment. Completion plug with "O" ring seal is inserted into tee through a gate valve to provide positive seal against leakage. Completion plug has internal equalizing valve which balances pressure on both sides of plug, assuring easy insertion into, or extraction from the tee while under pressure.

NO-BLO®

Write for complete information. A complete line of Mueller NO-BLO® products is available for making stop-offs, running temporary lines and making tie-ins under pressure.

**MUELLER CO.** **DECATUR, ILL.**

Factories at: Decatur, Chattanooga, Los Angeles,
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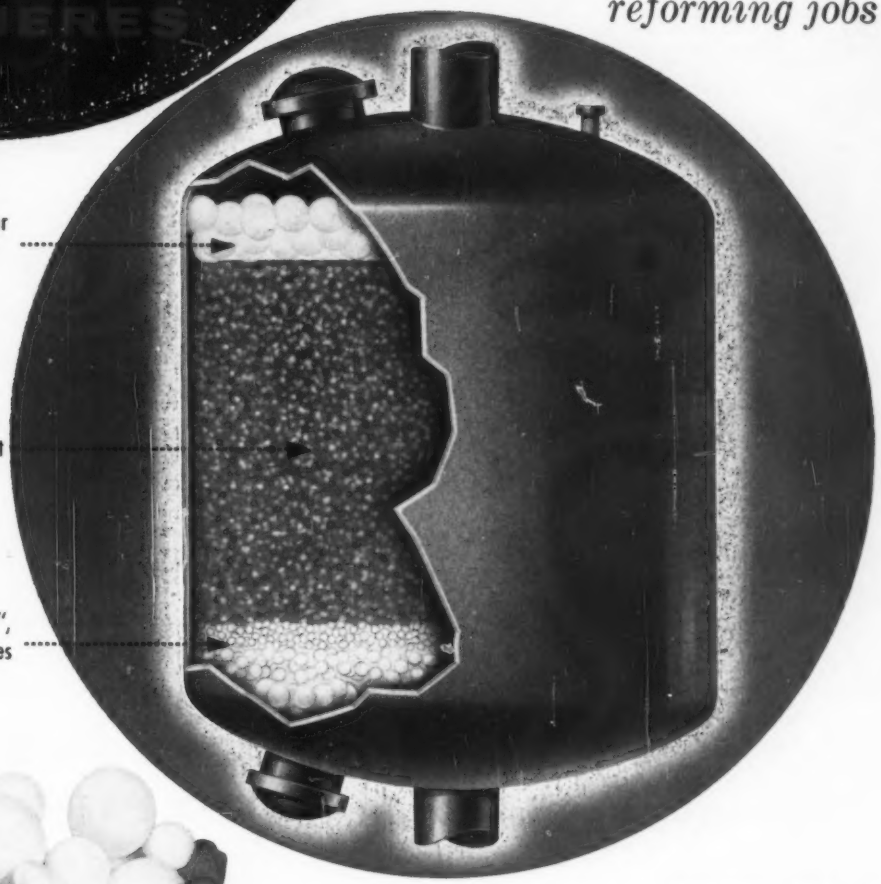
For more data on advertised products, use Readers' Service Cards, last page.

# PATTERSON ARLCITE SPHERES

*...tough customers for your toughest catalytic reforming jobs*



Inert, rugged, commercially proven—ARLCITE 86-8 Spheres when used as catalyst bed support and hold-down material thrive in operating conditions such as these—pressures of 550 to 750 psi.—temperatures to 2000°F. with instantaneous temperature changes of 200 to 250°F.

After two years service in one Gulf Coast refinery, Arlcite Spheres have shown no signs of failure or breakage, contributing to operating economy and peak production.

Arlcite 86-8 Spheres, a high alumina ceramic material, is scientifically bonded to assure the ultimate in mechanical strength, resistance to crushing, erosion and abrasion. Complete chemical inertness and smooth surface give freedom from contamination of highly sensitive and valuable catalysts.

*Write for complete details.*

- Chemically Inert
- Zero Absorption
- Stability at High Temperatures
- High Resistance to Shock
- Smooth Surface

FERRO

THE *Patterson* FOUNDRY AND MACHINE COMPANY
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THE *Patterson* FOUNDRY AND MACHINE CO. (CANADA) LTD.
Toronto, Ontario

*A Subsidiary of Ferro Corporation*



For more data on advertised products, use Readers' Service Cards, last page.

# SELECTIVE! EASY! FAST!

## that's petroleum refining with QO FURFURAL

**SELECTIVE**

QO FURFURAL is a polar molecule and gives *sharp* separation between mixtures of products present in lube stocks.

**EASY**

- QO FURFURAL is so stable, over 99.95% can be recovered easily by a simple system.
- QO FURFURAL is easy to store and easy to handle—even in icy weather.
- QO FURFURAL is easy to obtain in large quantities all year 'round.

**FAST**

QO FURFURAL's high specific gravity permits *rapid* phase separation. And faster refining means more economical refining.

**Leading petroleum companies have found that solvent refining with QO Furfural is an efficient and economical operation. Get the details on QO Furfural by writing today for Bulletin 203-A.**

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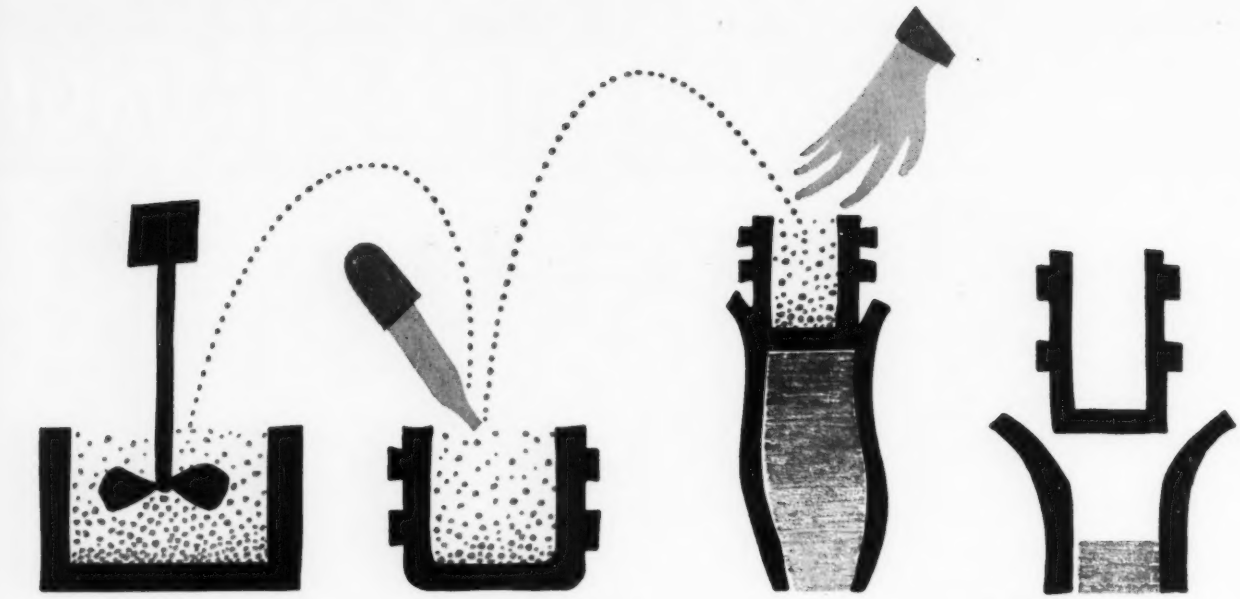
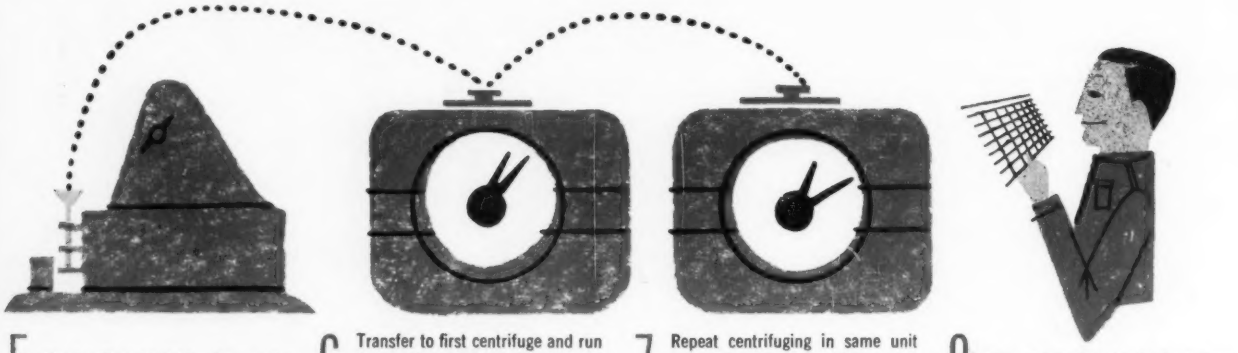


1. Prepare suspension of particles.
2. Transfer suspension to feeding chamber.
3. Transfer feeding chamber to centrifuge tube.
4. Remove feeding chamber, leaving sharp layer of suspension on top of sedimentation liquid.



5. Read sediment height under gravity in projector at precalculated times.
6. Transfer to first centrifuge and run for precalculated time, then remove and read in projector.
7. Repeat centrifuging in same unit or in higher speed centrifuges until run is complete.
8. Size distribution is obtained from sediment height data.

# New Low-Cost Way to Measure Size Distribution of Small Particles

With the new M-S-A® Particle Size Analyzer, you can start with a minimum investment for measuring particle distribution, and then expand it by the purchase of additional components.

This versatile analyzer is a general-purpose device for measuring size distribution of small particles. It is especially designed for measurement of subsieve particles between approximately 0.1 and 40 microns. Most airborne dusts, paint pigments, and many flours, chemicals, and pharmaceuticals lie within this range.

Complete analyzer system includes centrifuge tubes, feeding chamber, optical tube projector, one or more special centrifuges, and tube handling and cleaning accessories. Write for new bulletin for details.

Tube Projector

Centrifuges

MSA

**INSTRUMENT DIVISION**
**Mine Safety Appliances Company**
Pittsburgh 8, Pennsylvania

# THE YARWAY FAMILY OF FINE STEAM TRAPS

**SERIES 60**—normal needs, pressures to 400 psi, 6 sizes. **SERIES 120**—normal needs, pressures to 600 psi, 6 sizes. **SERIES 40**—for extra heavy loads, 5 sizes. **NO. 30**—for extra light loads (½" only). **INTEGRAL STRAINER**—highest pressures and marine use, 6 sizes.

# NEW NO. 30 IS A LIGHT LOAD SPECIALIST

When the condensate load in your steam lines is *extra light*—this new Yarway ½" No. 30 Steam Trap is *exactly right.*

Specify it. You'll experience new *economy of operation* with the *tighter shut-off*. Operation is *quieter* due to lever action. *Maintenance is less*—because of the replaceable valve-seat assembly, only one moving part and stainless steel construction. Enjoy these special features plus all the regular advantages of famous Yarway Impulse Traps such as *quick heating, even temperatures, small size, good for all pressures, non-freezing.*

Over 1,250,000 Yarway Impulse Traps already sold; buy yours from one of 270 local Industrial Distributors.

**YARNALL-WARING COMPANY**
128 Mermaid Ave., Philadelphia 18, Pa.

**YARWAY** *impulse® steam traps*

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# MILLIONS OF BARRELS OF OIL

## *Scientific efforts of*

*Emulsified crude oil burning in early Oklahoma field. Such burning was carried on in all the oil fields, resulting in the destruction of millions of barrels of oil.*

*Waste oil flowing in stream, Caddo, Louisiana, about 1918.*

*Sun treating at Osage, early 1900's.*

*William S. Barnickel*

The name of William S. Barnickel is known only to a few "old-timers" in the petroleum industry, although everyone in this industry has benefited from the results of his efforts.

Shortly after the turn of the century, while Barnickel was at Kiefer, Oklahoma, near the then booming Glenn Pool, he was impressed and dismayed by the terrific losses involving "cut" or emulsified oil. At that time, when produced oil showed any substantial percentage of emulsified water, it was deemed unfit for refining, and was rejected and disposed of.

Disposal sometimes consisted simply in wasting the cut oil into the nearest stream, but when this practice could not be tolerated, the oil was run into pits and burned. Burning cut-oil sumps were a characteristic feature of many of the early oil fields.

The first attempts to salvage emulsified production also were wasteful. Sometimes the oil was "sun-treated," i.e., run into pits so that the heat of the sun would warm the oil, lessen the viscosity, and allow water and emulsion concentrate to settle out. Another method frequently used was to boil out the water. While these methods sometimes were relatively successful, they still were wasteful and expensive. The losses in volume and gravity by evaporation were the greatest wastes. Time, pollution and heating costs were others.

While these wasteful practices were being accepted as normal operating procedures, Barnickel returned to St. Louis determined to find a better way to recover oil from emulsion. His early struggles toward this end were similar to those of other pioneers in science, before and since. He was beset by failure, discouragement and disinterest.

In spite of these adversities, by 1911 Barnickel had developed what he believed would be an effective chemical for petroleum demulsification. He journeyed back to the oil fields, this time in Louisiana. Here a new well was producing freely and filling all available storage space with oil. The difficulty, however, was that the oil was stably emulsified with water and therefore deemed worthless.

Barnickel applied his chemical demulsifier and recovered 56,000 barrels of "clean," usable oil. Although his next attempt (in a different field) was a complete failure, Barnickel still believed in his basic idea and his ability to conquer the problem. He continued

*Original Tretolite factory.*

# SAVED BY INVENTOR OF TRET-O-LITE

## *St. Louis chemist revolutionized the handling of "cut" oil*

his work and soon had developed the first really successful chemical demulsifier. It was in solid form, and was turned out by Barnickel in a small rented factory building in downtown St. Louis. He named this product "Tret-O-lite."

In spite of the performance of the new product, sales were slow, and William S. Barnickel & Company struggled through several more years of discouragement. Barnickel continued his efforts to develop a better, more effective treating chemical. In 1919 he developed a liquid Tret-O-lite formula which proved to be five times as effective as his solid Tret-O-lite. The new product caught on, and soon substantial orders began to roll in. Barnickel, and Tret-O-lite, had succeeded.

### WHAT THIS MEANT TO BARNICKEL

Barnickel's struggles had been frustrating and heart-breaking. He succeeded in the face of indifference and skepticism, even ridicule—as have other great contributors to progress. His concentrated and almost continuous attack on the cut oil problem took its toll. In spite of his final spectacular success, William Barnickel had given too much; he died in 1923 at the age of 45.

### WHAT BARNICKEL'S WORK MEANT TO THE OIL INDUSTRY

To visualize the importance of Barnickel's discovery it is only necessary to realize that some 80% of all oil produced in the U. S. contains some water, usually in the form of an emulsion. Much of this would be useless if it were not demulsified. It is also estimated that nearly as many barrels of water as of oil are produced. If this water and oil were not completely and efficiently separated, it is easy to imagine the costly and complicated disposal and pollution problems that would arise.

It is probably safe to say that Barnickel's life work resulted in one of the most significant conservation measures ever developed for the oil industry.

### TRETOLITE TODAY

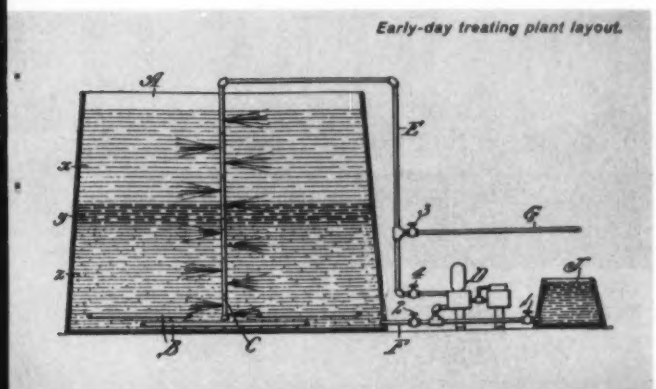
William S. Barnickel & Company was the predecessor of the Tretolite Company, which now operates as two divisions of Petrolite Corporation. One division is headquartered in Webster Groves, a Saint Louis suburb, and serves the eastern, mid-continent, Latin America and European areas. The other division has its headquarters in Los Angeles, and serves the Four Corners, Pacific Coast and the Orient. Subsidiary companies also are located in Canada, Mexico, Venezuela and Europe.

The present Tretolite organizations carry on the spirit of their founder. Having been established in the pioneering tradition ,the Tretolite Companies have accepted the responsibilities that go with leadership. From Barnickel's "one salesman" has grown a staff of Field Service Engineers numbering in the hundreds and located in every oil producing or refining area.

The Tretolite Companies have not confined their efforts to the production of better demulsifying chemicals. They have originated and developed many other helpful products for industry, among which are Kontol* corrosion inhibitors, Tret-O-lite* desalting chemicals, Solvo* paraffin removers, Fludex* water-flood additives, S. P. scale preventives, Kuplex* metal deactivators for petroleum products, Dehydro* asphalt anti-stripping additives, Tolad* fuel additives, Vez* anti-foamers and many others.

*Present-day Tretolite facilities at St. Louis*

*Tretolite factory, offices and laboratory at Los Angeles.*



*Early-day treating plant layout.*

# TRETOLITE COMPANY

DIVISIONS OF PETROLITE CORPORATION

CHEMICALS and SERVICES for the PETROLEUM INDUSTRY

**369 Marshall Avenue, Saint Louis 19, Missouri**
**5515 Telegraph Road, Los Angeles 22, California**

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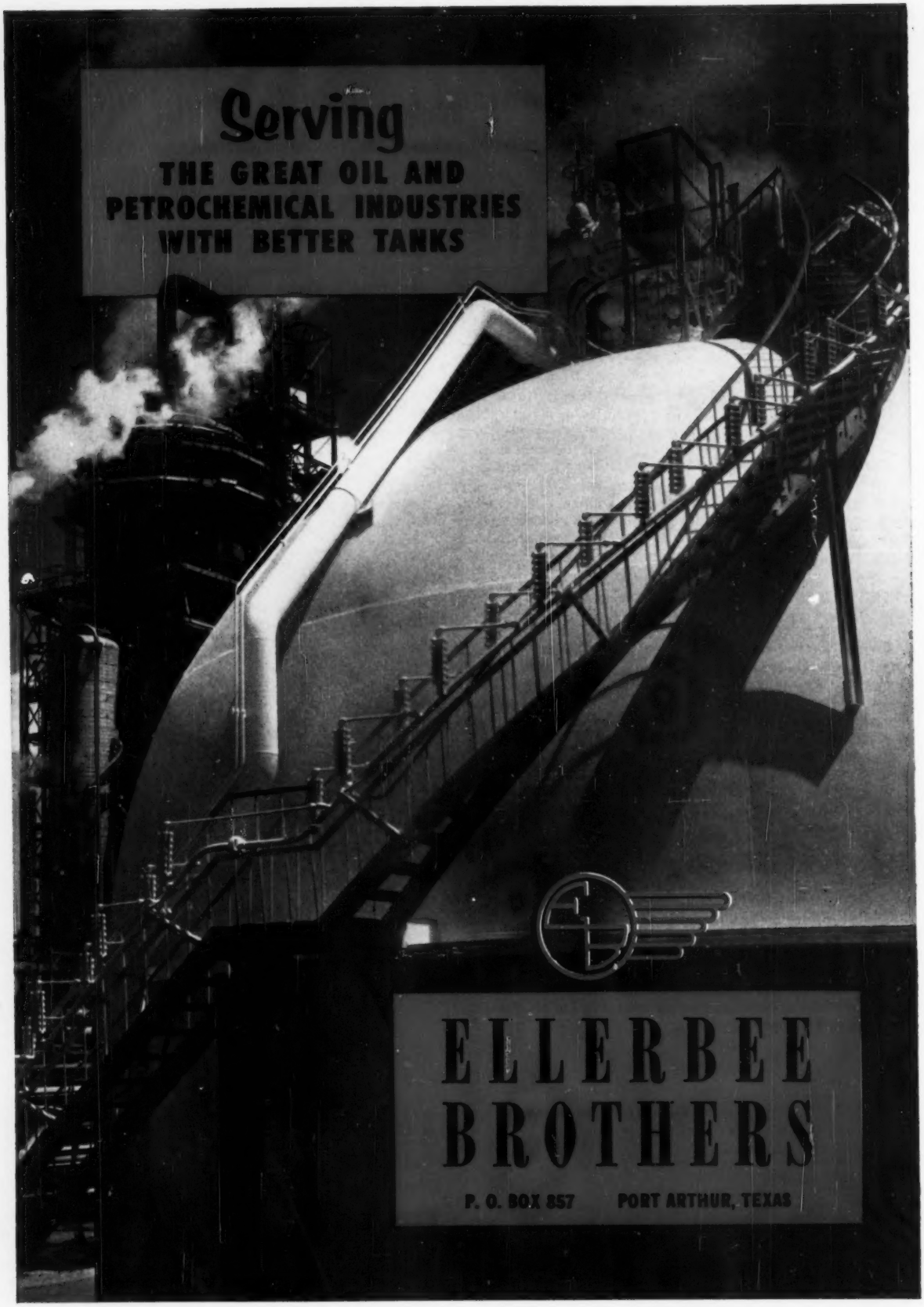
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THE GREAT OIL AND
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# clean separation*

*99.9% plus
entrainment removal

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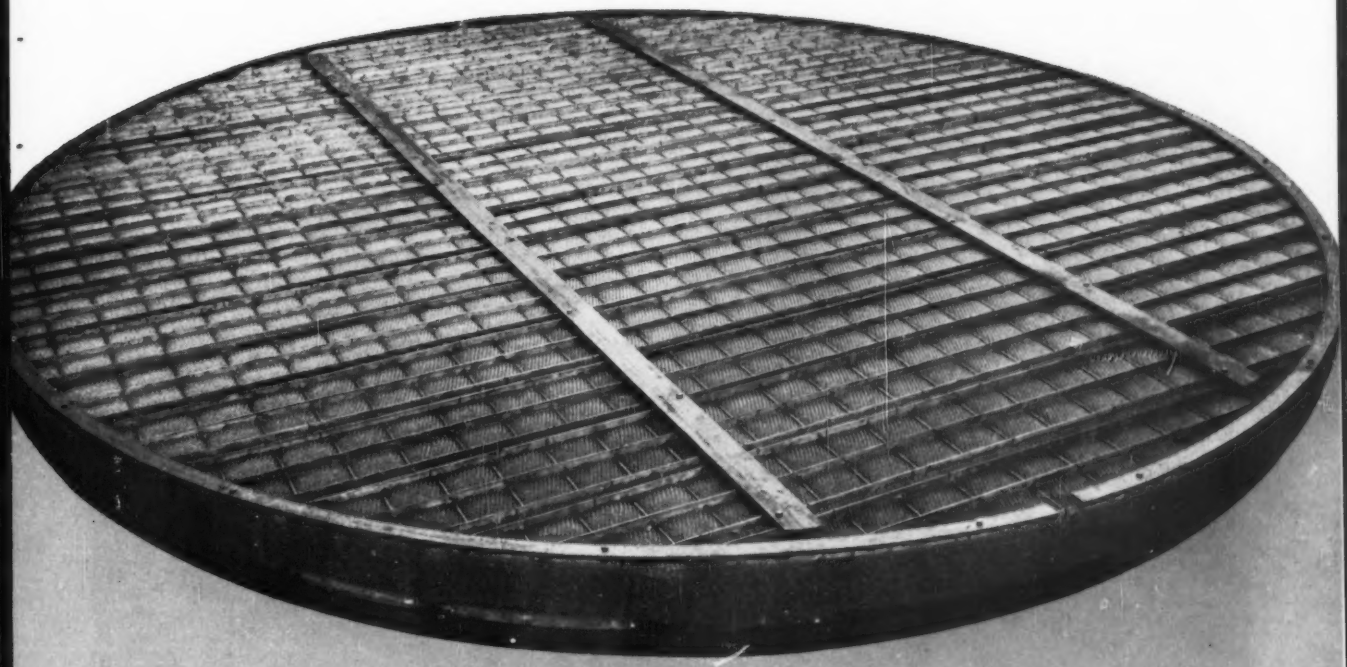
the oil industry for 100
years of refining progress and
are proud of the contributions that
YORKMESH DEMISTERS
have made in the past
11 years to the many
advancements in
refining techniques.



**YORKMESH DEMISTERS®** enter the picture whenever clean separation between vapor and liquid is important. YORK has specialized for many years in problems such as improving product quality, increasing thruput capacity, reducing maintenance costs, eliminating entrainment losses and controlling pollution. Send details on your operating conditions so that York engineers can study, evaluate and take full responsibility for furnishing the ideal Demister. Our recommendations are unconditionally guaranteed to give the performance specified.

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*give excellent performance in:*
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An increasing number of cost-conscious engineers are switching to aluminum rigid conduit for office buildings, industrial plants and other new and remodeled structures. Here are some of the reasons why:

- Lower prices plus light weight and ease in handling make Alcoa® Aluminum Conduit installations competitive.
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Underwriters' Laboratories, Inc. INSPECTED RIGID CONDUIT ISSUE MU-28

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For more data on advertised products, use Readers' Service Cards, last page.

WOLVERINE
# TUBE
Items of Interest to the Processing Industry

PUBLISHED BY WOLVERINE TUBE DIVISION

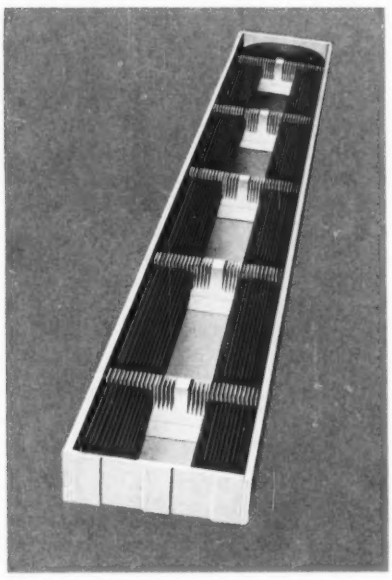
## Wolverine Prefabs U-bends to your Specifications

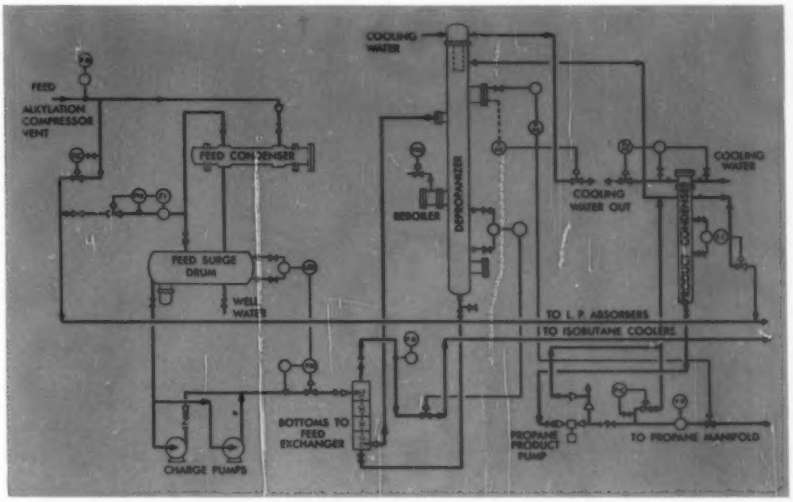
As a direct mill source Wolverine Tube prefabricates U-bend condenser tubes to your specifications — ships them in disposable type pallets in the exact order of their installation — ready for direct insertion into your heat exchanger or condenser.

In addition to real savings in assembly time, you minimize transportation, space and handling problems.

In prime surface form Wolverine U-bends are available in a wide range of sizes and alloys in copper and aluminum. Capacity boosting Wolverine Trufin U-bends (such as those used in this application) are available in copper, copper alloys, aluminum and seamless steel. Wolverine Trufin tubes can be furnished in straight lengths or bent to your specification and packaged as shown here.

Write for complete information — or have your Wolverine sales representative explain their advantages. He is as near as your telephone.






***Here's How:***

# WOLVERINE TRUFIN® CUT COSTS IN ALKY-SYSTEM DEPROPANIZER

**BY ERNEST DODD**

In refining—as in all industry—using the *right* product at the *right* time can often result in savings amounting to thousands of dollars.

A recent article in a trade publication gives dramatic evidence of the value of low-fin (Wolverine Trufin) condenser tubes in the design of the above low-cost alky-system depropanizer at a large Gulf Coast refinery.

From the article: "The advantage for the internal heat exchangers, low-fin U-tube bundles, lies in the investment savings in shells, floating heads and separate foundations." — "The advantage to this design in terms of the first cost is achieved principally by locating the reboiler and the overhead condenser inside the tower.

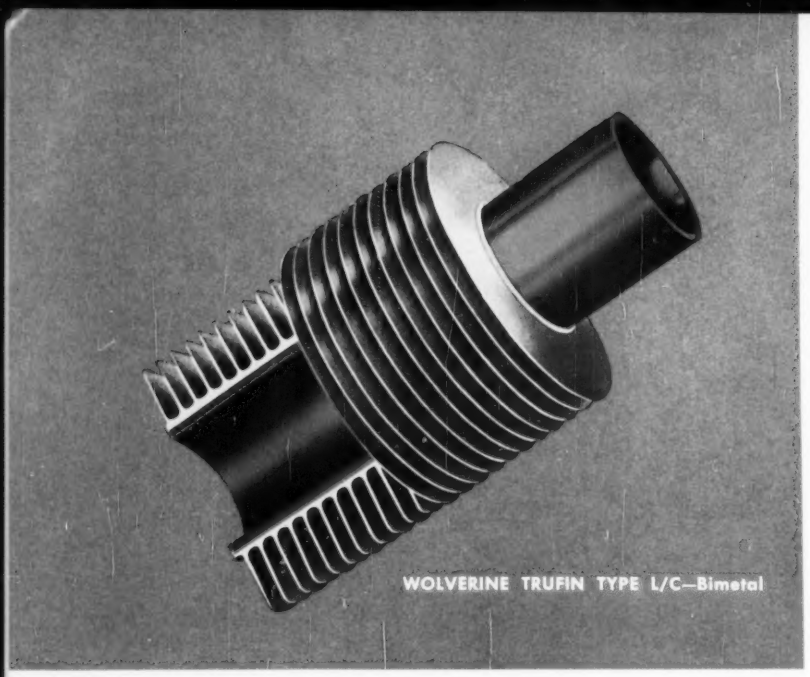
"This was achieved by the use of finned tubes to obtain high heat input per cubic foot of tower volume. It is estimated that the savings in terms of externally located heat-exchanger shells and foundations are about $10,000. This saving is about 25 per cent of the cost of the tower itself, and 6 per cent of the total cost of the project."

The major components in the system were: (a) a feed condenser using 70° well water makeup to the reservoir as coolant; (b) a 60-foot high by 30-inch diameter tower using Spraybak cartridge packing for liquid and vapor contacting; (c) *an internal reboiler and reflux condenser;* (d) an external product condenser doubling as a product accumulator, a bottoms-to-feed exchanger and one product pump.

It was in the area of item (c) that Wolverine Trufin proved its ability as a money saver. Internal mounting was advantageous in this instance because of Wolverine Trufin's greatly increased surface area. This enabled the engineers to get more heat transfer surface into a given area thus obtaining a higher heat input per cubic foot of tower volume.

Where Wolverine Trufin is installed *savings* and *increased heat transfer performance* go hand in hand. Throughout industry authenticated cases such as that described here are becoming daily happenings.

May we suggest that you include Trufin tube in your engineering philosophy when designing heat exchangers for your use?



WOLVERINE TRUFIN TYPE L/C—Bimetal

PRIME SURFACE DUPLEX TUBING

WOLVERINE TRUFIN TYPE S/T—Duplex

# WOLVERINE BIMETALLIC TUBE IS B-R*

* *(BOND RESISTANCE RATED)*

Designing new equipment using bimetallic or duplex type heat exchanger tube?

Then here's good news for you.

NOW — Wolverine Tube can tell you in advance exactly the amount of bond resistance between the inner and outer tubes of mechanically bonded tubing of dissimilar metals.

For example, production testing of Wolverine Trufin® Type L/C assures customers that this high-finned aluminum outer tube can be mechanically bonded to an inner liner of any desired metal and still maintain an assured and predetermined heat transfer rate. Equally precise production testing of resistance values can be given on all other Wolverine finned and prime surface duplex tubing.

With this information determined in advance by Wolverine's newly developed bond resistance testing machine, it is now possible to obtain increased accuracy of design for heat exchangers and condensers using duplex tubing. This is of greatest importance where such tubing is used to combat corrosion.

Write — NOW — for complete information or ask for a Wolverine Technical Sales Representative to call.

Wolverine Trufin is available in Canada through the Unifin Tube Division, London, Ontario.

CALUMET & HECLA, INC.
CALUMET DIVISION
URANIUM DIVISION
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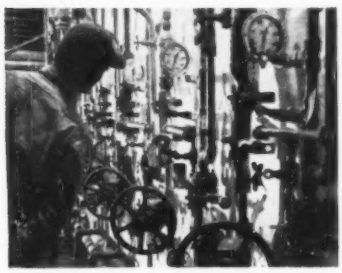
## Why external recalibration is important to users of industrial thermometers

Sometimes it is necessary to recalibrate thermometers in industrial installations due to severe shock from rough handling, or to calibrate for extreme accuracy at any point on the scale for special work range.

To recalibrate the ordinary bimetal thermometer, you must remove the dial glass and move the pointer by hand. You will achieve the desired recalibration of course, but a number of undesirable things may also result. First of all, the instrument's air-tight seal is automatically destroyed in the removal of the dial glass. Secondly, in forcing the pointer, the pointer shaft may become bent or twisted.

Should the pointer shaft become bent even slightly, it can cause the pointer to stick due to improper alignment of the bimetallic shaft on its bearing surfaces. The obvious result, of course, will be inaccurate readings and necessary repair or replacement of the instrument. *None* of these things can happen with the RMC external recalibration device.

A simple dial-reset screw, located on the back side of RMC industrial thermometers, permits recalibration without opening the instrument in any way. This external recalibration feature is *exclusive* with RMC, along with true dry-air hermetic sealing.



SHIPPINGPORT, Pa.—Heavy-duty dial thermometers play an important role in the operation of the world's first full-scale atomic-electric generating station devoted exclusively to civilian needs. These thermometers, manufactured by RMC, can be recalibrated externally. The plant is a joint project of Westinghouse Electric Corporation, Atomic Energy Commission and Duquesne Light Company of Pittsburgh.

## RMC high pressure gauge, developed for missiles, now available to industry

RMC-LINDSAY PRESSUREGAUGES indicate pressures in ranges 0 to 1,000 psi., up to 0 to 15,000 psi., with retard scales available. Multiple coil, helical Bourdon tube type, with pointer attached direct—no linkages or pivots. Can withstand extreme shock, vibration, temperature, or overpressure and maintain consistent accuracy.

**Write, wire or phone—tell us your requirements for indicating instruments, and let RMC engineering skill go to work for you. ROCHESTER MFG. CO., 38 Rockwood St., Rochester 10, N. Y.**

This maintenance engineer is recalibrating an RMC bimetal dial thermometer by means of the exclusive RMC *external* dial reset screw—a simple on-the-job operation with RMC thermometers.

# RMC external recalibration device saves thermometer's hermetic seal

With this *external* dial reset screw you can recalibrate your RMC thermometer easily and safely, should it ever be necessary. The all-important hermetic seal cannot be destroyed and there is no chance for damage to the critical pointer shaft. You get the *only* bimetal industrial thermometer that provides for *external* recalibration when you specify RMC.

RMC

**ROCHESTER MANUFACTURING CO., INC.**
**38 ROCKWOOD STREET • ROCHESTER 10, N.Y.**

LIQUID LEVEL, TEMPERATURE and PRESSURE INSTRUMENTS

**REPRESENTATIVES IN ALL PRINCIPAL CITIES**



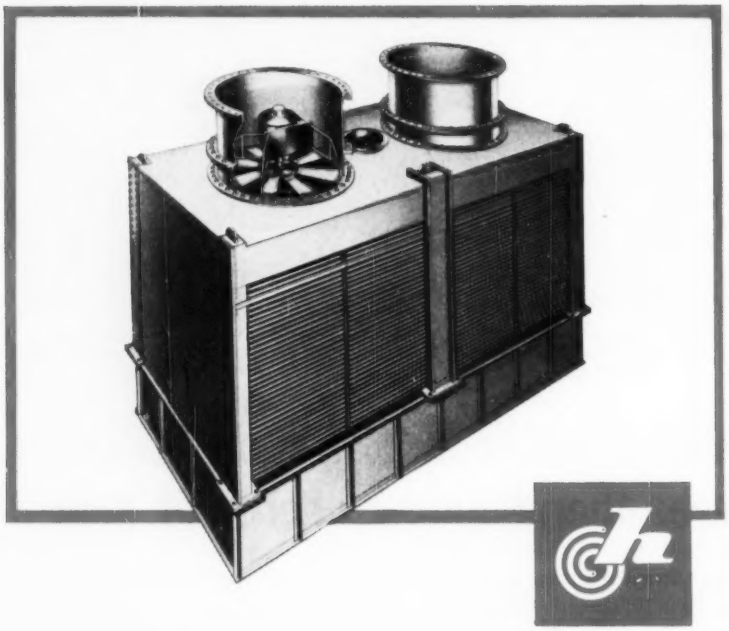
For more data on advertised products, use Readers' Service Cards, last page.

# Are YOU, TOO, doing it the hard way?

No good fiddler would play like this. And certainly no capable engineer wants to solve his cooling problem the hard way. Our latest development, the **Aquamizer**® (we have been perfecting it for over two years) offers you an easy solution.

Your next question—what is an **Aquamizer?**

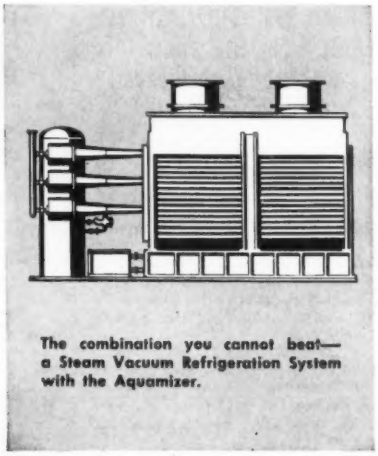
Here it is—the most modern concept of an evaporative vacuum condenser. If you have a cooling water problem and require a surface condenser on any vacuum system, it's an item you can't overlook, since it uses no external source of water.



## AND . . .

. . . if you want really cold water we offer you a Steam Vacuum Refrigeration System equipped with an **Aquamizer.** Here is a means of providing large quantities of cold water down to 35°F and, as stated above, requires no external source of cooling water.

For complete information on either of these items consult our nearest office.



**The combination you cannot beat—a Steam Vacuum Refrigeration System with the Aquamizer.**

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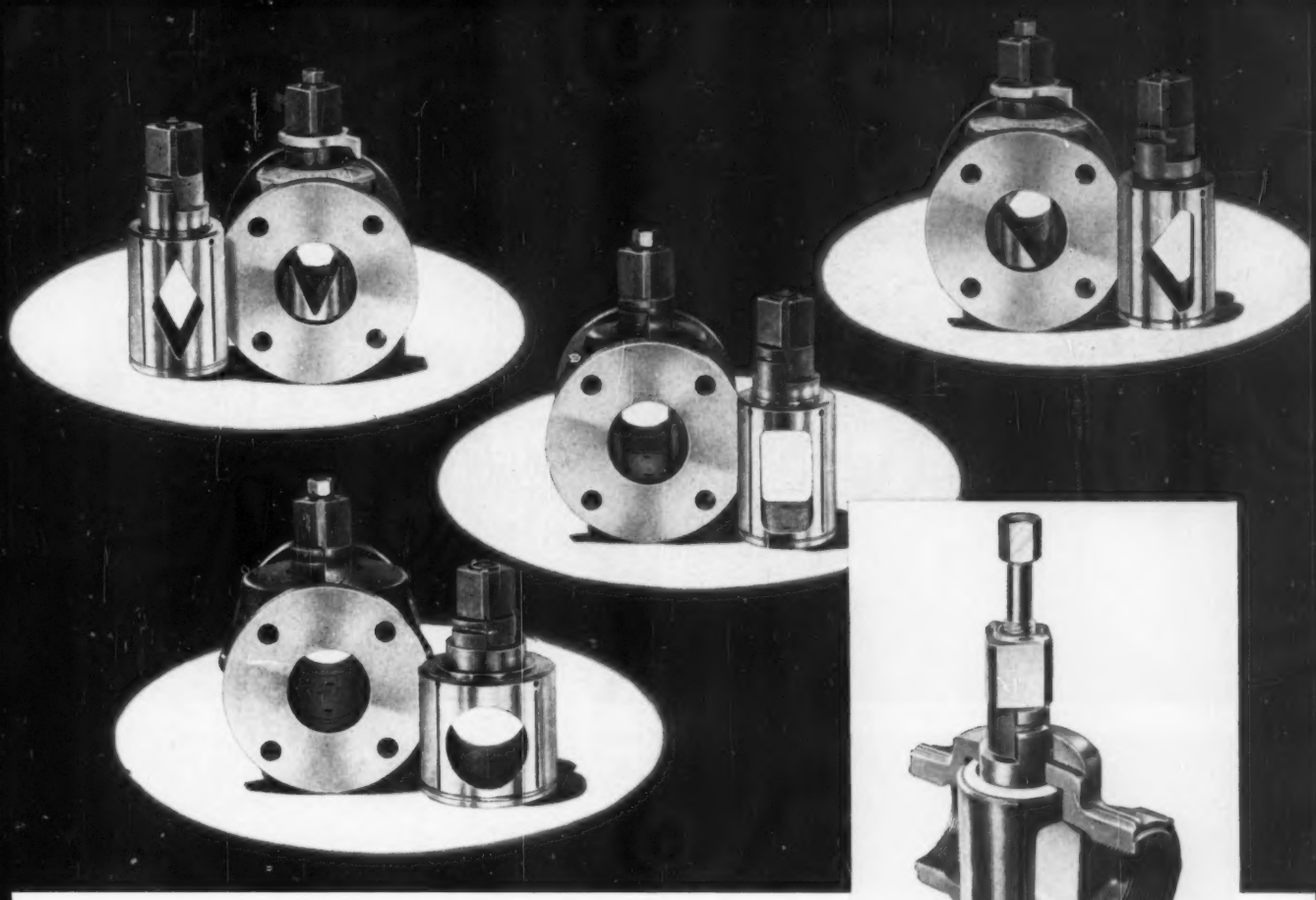
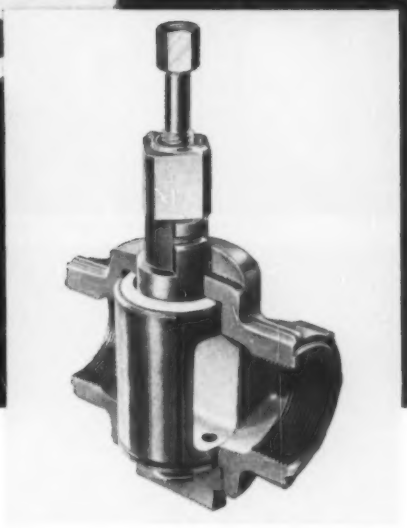
***Offices in principal cities and Canada***





# W-K-M's *Creative Engineering*

## assures the dependable performance of W-K-M's acf Lubricated Plug Valves

Lubricated plug valves are the work-horse valves of industry. They're versatile, they're economical, they're readily available.

But one lubricated plug valve is not "just as good as another!" The ACF Cylindrical Plug Valve has many advantages.

W-K-M's creative engineering has designed the ACF valve to give you longer life, greater efficiency, minimum maintenance. W-K-M production pays constant attention to the manufacturing details that spell the difference between a "pretty good valve" and the best you can use. W-K-M tests every ACF valve against requirements much beyond the use for which it is rated.

In short, W-K-M's creative engineering assures you *dependable performance* from every ACF Lubricated Plug Valve in your plant.

### Advantages of acf® Lubricated Plug Valves

These versatile valves have full pipe area openings. They provide through-conduit flow with minimum turbulence and minimum pressure drop.

They can be installed in any position. They can be serviced quickly.

They are safe against rupture while lubricating—excess lubricant escapes visibly to the atmosphere around the neck of the plug; this eliminates build-up of lubricant pressure, prevents lubricant from escaping into the line.

Lubricant protects against corrosion.

Available in semi-steel, Ni-resist, carbon steel, bronze and aluminum.

**WRITE FOR CATALOG 400**

**W-K-M**

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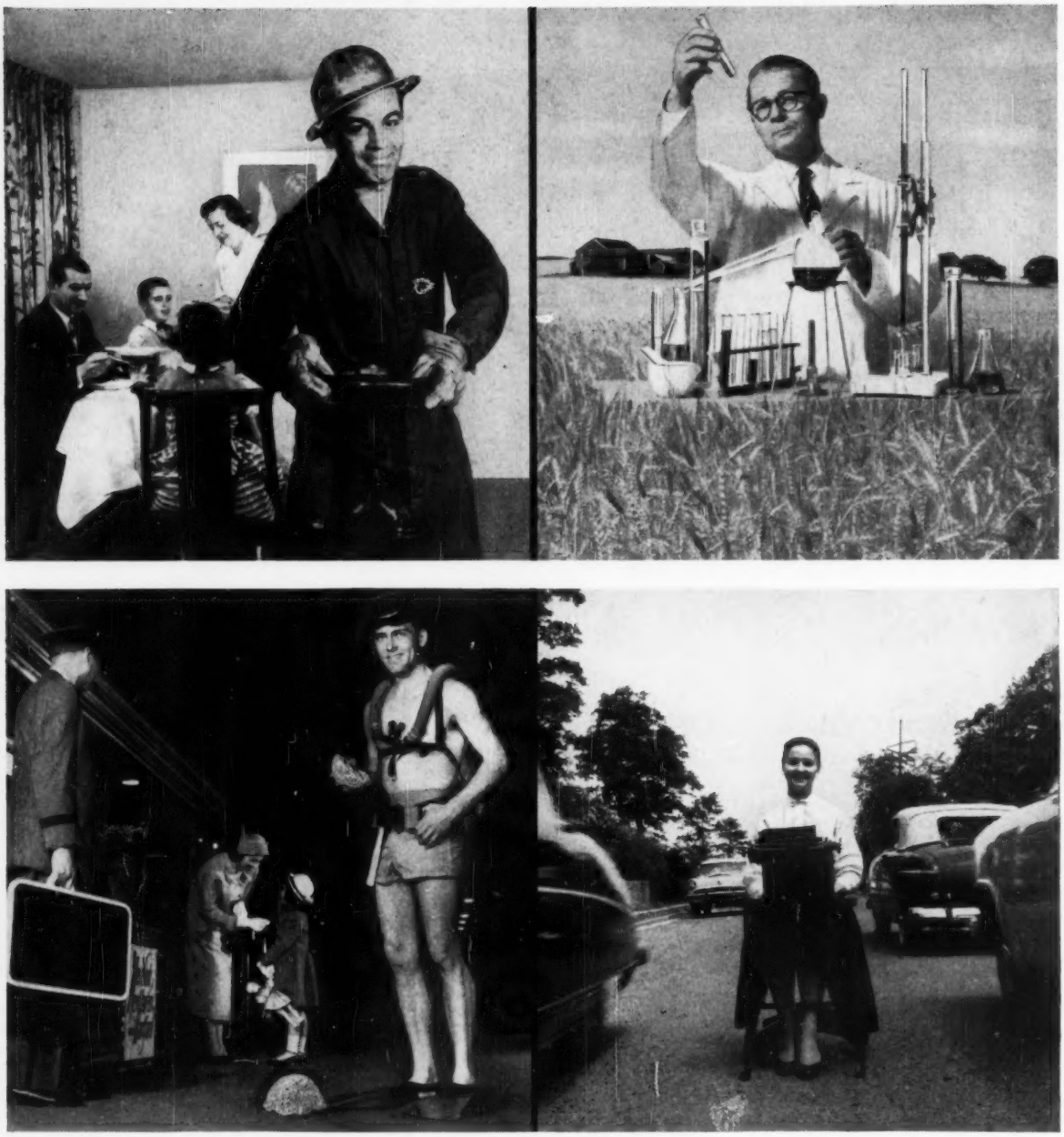


**Shell salutes the oilman–and woman, too.** Together they produce and supply three-fourths of the energy for a dynamic America. Their versatility is limitless–as shown by a hundred kinds of specialists. Chemist, farmer, executive, driller, skin diver, geologist, secretary. Without them, there would be no centennial celebration this year–and not much of a world.

**SHELL OIL COMPANY**

# Another Step-Up in Nalco® and Visco® SERVICES for the Petroleum Industry

## Visco Offers Chemicals and Services For Oil Production

Effective at once, Visco offers sales and service of Nalco products used in petroleum production: chemical treatments for water injection projects and salt water disposal systems.

These chemicals and services combine with Visco emulsion breakers, corrosion inhibitors, and paraffin control in field applications to give your Visco Field Service Man a full kit of important tools to help you deliver acceptable crude at lowest treating cost per barrel; and to keep maintenance costs on wells and surface equipment at a minimum.

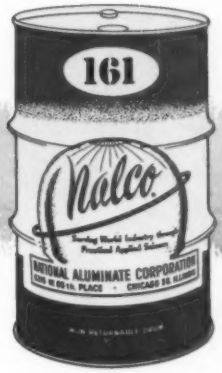
Nalco and Visco men are working together to achieve a smooth transition. The same effective treating methods and chemicals will be used and all the background of successful research and experience of both Nalco and Visco will be available to you through your Visco representative.

For prompt action on your field treating, call your Visco Field Service Man, or write Visco Products Company, Inc., 1020 Holcombe, Blvd., Houston 25, Texas.

## Nalco Handles Chemicals and Services For Refineries

As Visco takes on the sales and service of all Nalco and Visco products used in petroleum production, Nalco will handle application of the chemicals of both companies in refineries and gas, natural gasoline and petrochemical plants.

Nalco and Visco began streamlining refinery services in 1957 when Visco corrosion control treatments were added to those being serviced by Nalco Representatives. Availability of Visco refinery desalting treatments through Nalco completes the service function specialization: Nalco for refining; Visco for production.




Your Nalco Representative can now provide cost-cutting treatments for:

**Corrosion Control** in refinery hydrocarbon systems.

**Stabilization** of finished petroleum products.

**Desalting** for refining and petrochemical processing.

**Corrosion, Scale and Microbiological Control** for cooling, steam and process waters.

Other Nalco Divisions serving the petroleum industry are: Ion Exchange Division, high-capacity ion exchange resins; and Catalyst Division, Nalcat Cracking and Hydrogen Treating Catalysts.

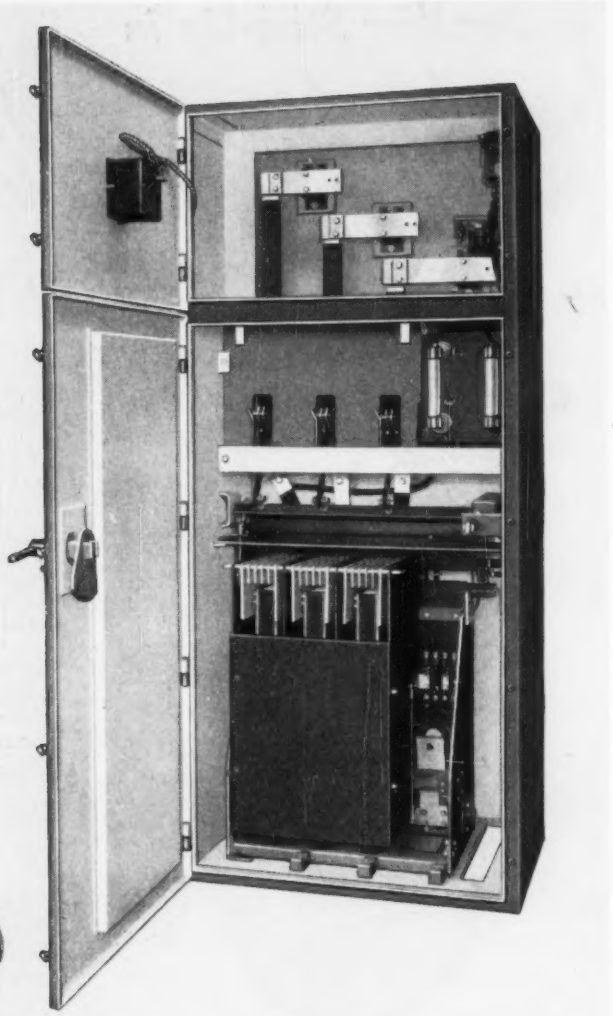
For details on any or all Nalco chemicals and services for the petroleum industry, ask your Nalco Representative, or write: National Aluminate Corporation, 6259 W. 66th Place, Chicago 38, Illinois.

**VISCO PRODUCTS COMPANY is a unit of NATIONAL ALUMINATE CORPORATION**

Nalco CHEMICALS
Visco CHEMICALS

# NEW EC&M STARTER

## GIVES 100/150 MVA fault protection



## WITHOUT FUSES!

Proven by tests conducted by an independent testing station, EC&M's new "fuseless" ZHA air-break starter has a certified interrupting capacity of 100,000 KVA at 2400 volts, 150,000 KVA at 4800 volts. This starter is simpler and much more accessible for inspection and checking connections.

The ZHA starter is not subject to problems associated with fuses. Single phasing due to blown fuses is eliminated...no costly replacement fuses to stock.

For positive personnel safety, the ZHA is equipped with a 3-way doorlatch, interlocked between disconnect switch and contactor interlocking system. The disconnect switch is gang-operated. When the door is open, disconnect blades are *visible* in the open and grounded position.

No roll-out needed...phase barrier and arc-chutes draw out horizontally, making front and rear contact tips readily accessible. Bus bars are used for power connections throughout the starter. Redesigned arc-chutes and interphase barrier, and improved contactor are additional features which make the ZHA starter your logical choice for high-voltage motor drives.

***GET THE COMPLETE STORY** on certified fuseless fault protection for high-voltage motor drives. Write for Bulletin 8130*

**THE ELECTRIC CONTROLLER & MFG. CO.**
*A DIVISION OF THE SQUARE D COMPANY*
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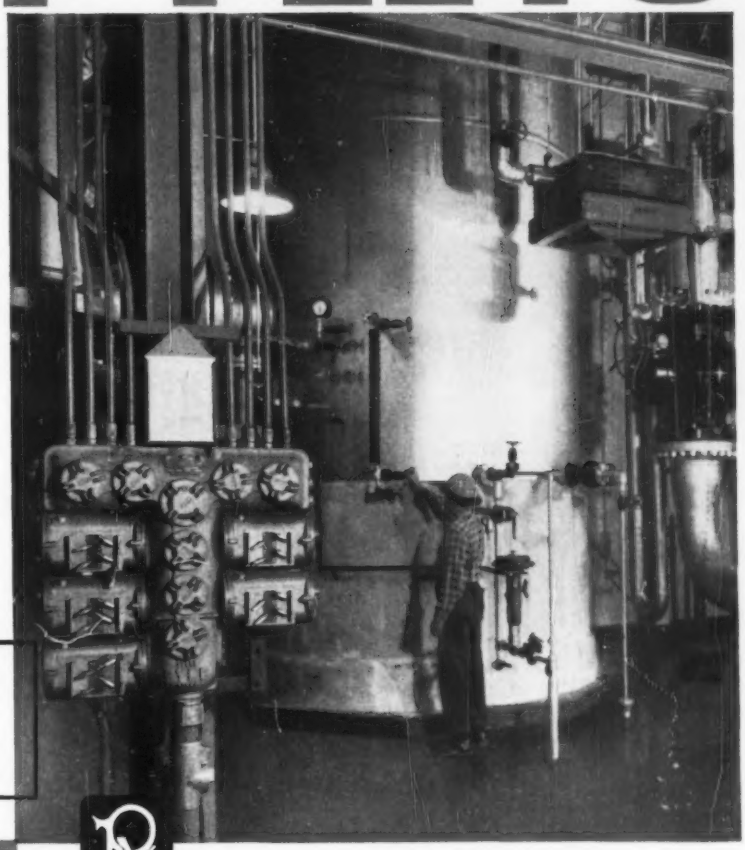
# explosion-proof PYLETS®

**specified for McMahon Gas Processing Plant Fort St. John British Columbia**

Explosion-proof PYLETS exceed code requirements and provide maximum protection for personnel and property against explosion and fire.

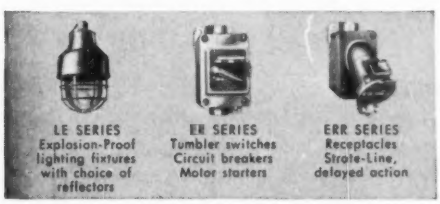
PYLETS are designed for quick, easy installation and convenient maintenance. Rugged construction insures a long service life.

- **Taper tapped hubs**
- **Smooth, roomy interiors**
- **Quick acting joints**
- **Dependable Mechanisms**
- **Aluminum alloy or heavy cadmium plated ferrous alloy castings**



**Pyle-National panelboard, lighting fixtures, and other Pylets in Absorption & Dehydrating building, McMahon Gas Processing Plant. Stearns-Roger Engineering Co., Ltd. specified Pyle-National controls, conduit fittings and lighting fixtures throughout.**

GJ SERIES
Threaded cover junction PYLETS with any arrangement of tapped or threaded hubs
ERC SERIES
Combination push button station and pilot light.

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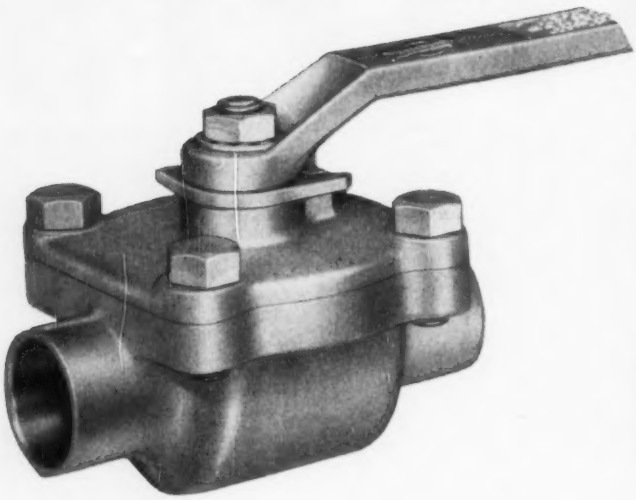
**CONDUIT FITTINGS • MOTOR CONTROLS • CONNECTORS • FLOODLIGHTS**

# Simple to Service ...on-the-line!



## The Rockwood Top Entry Ball Valve

Here's the advanced-design ball valve that's practically as easy to service as it is to operate. Ideal for oil, gas, oxygen, or hazardous liquids, it's a real time and money saver. Check the specifications below, then mail coupon for complete details.

*Specifications:* Cast Bronze; Buna N Seals; Forged Hard Chrome Plated Ball; Beryllium Copper Spring; Buna N Seats (also available in Teflon, nylon, and Viton-A); Sweat or Thread Ends; Sizes: ½", ¾", 1", 2"; 300 p.s.i. — W.O.G.

**ROCKWOOD BALL VALVES**

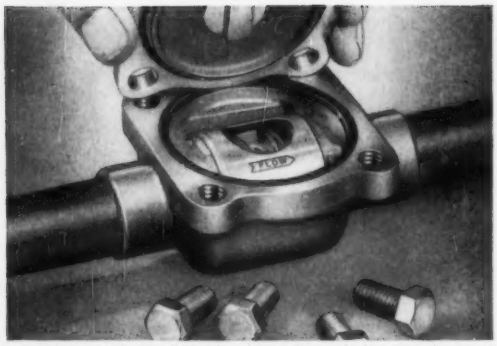
*FULL, ROUND FLOW*

*Distributors in all principal industrial areas*

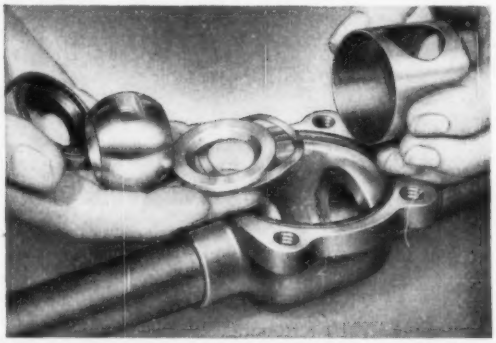
**ROCKWOOD SPRINKLER COMPANY**
1027 Harlow Street, Worcester 5, Mass.

Please send me complete details on the Rockwood Top Entry Ball Valve.

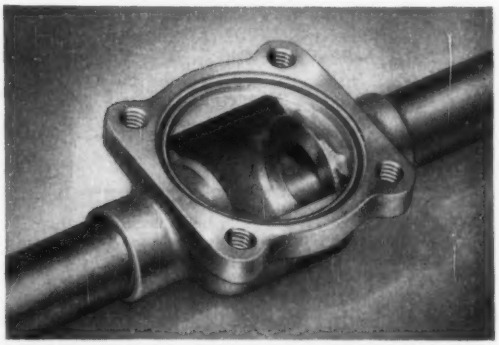
*Name* .....
*Title* .....
*Company* .....
*Street* .....
*City* ..... *Zone* ..... *State* .....



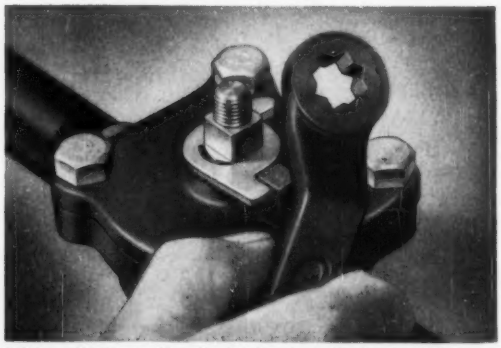
**Direction of shut-off** can be changed merely by reversing cage assembly. After removal of four screws, the body cap lifts right off, permitting access to the internal parts of the valve without removal from the line.



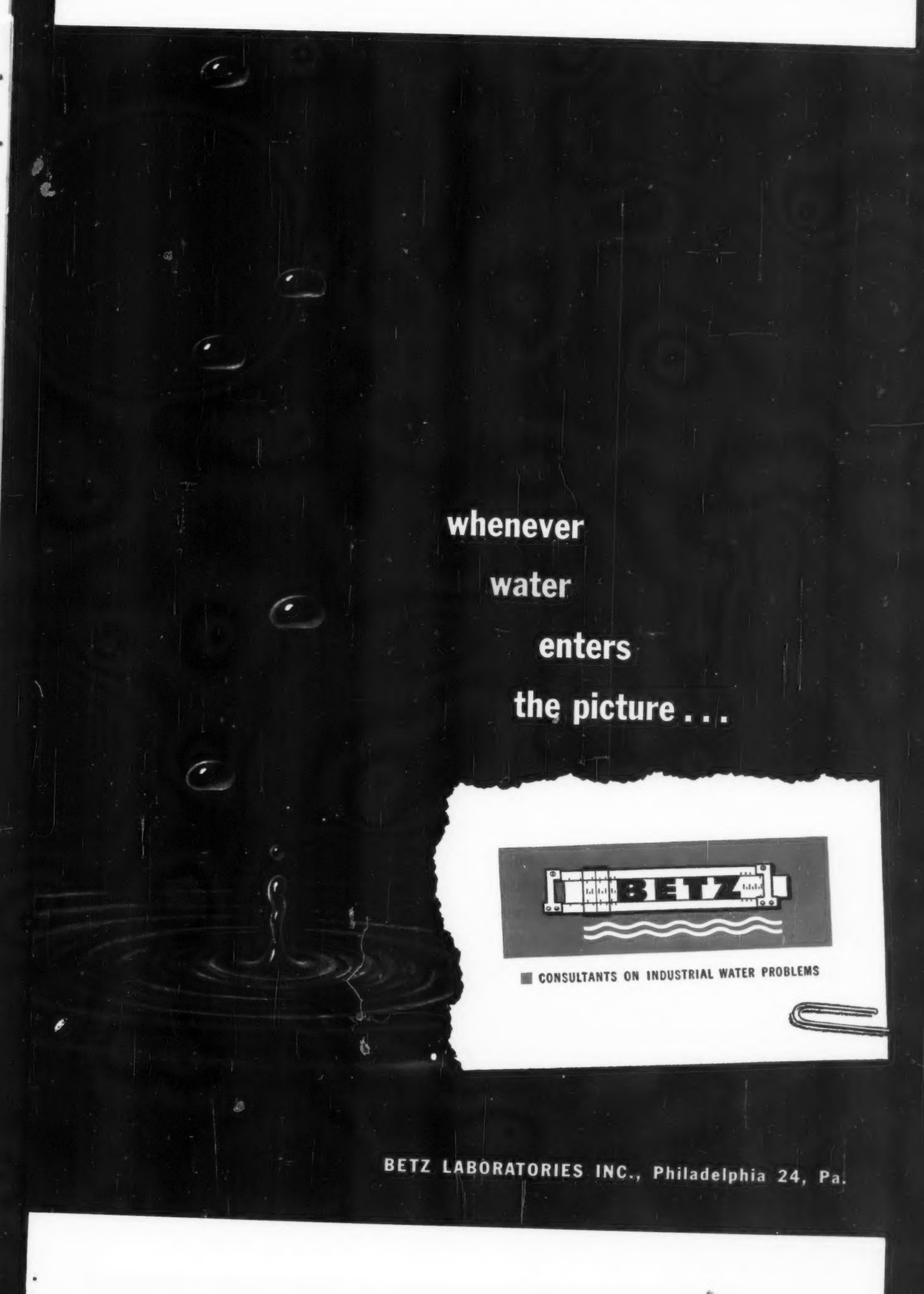
**Changing Type of Seat:** Cage assembly removes easily without special tools. Seat, seat retainer, spring, retainer, and ball removed as one unit for service or replacement.



**Cleaning:** Simple design and construction of body permits valve to be completely cleaned quickly and easily.



**8 Ways Easier to Handle During Installation and Operation, Too** — because square stem design permits on-off operation in any of 8 positions. Rugged stem keys directly into floating ball.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the picture . . .
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CONSULTANTS ON INDUSTRIAL WATER PROBLEMS
BETZ LABORATORIES INC., Philadelphia 24, Pa.

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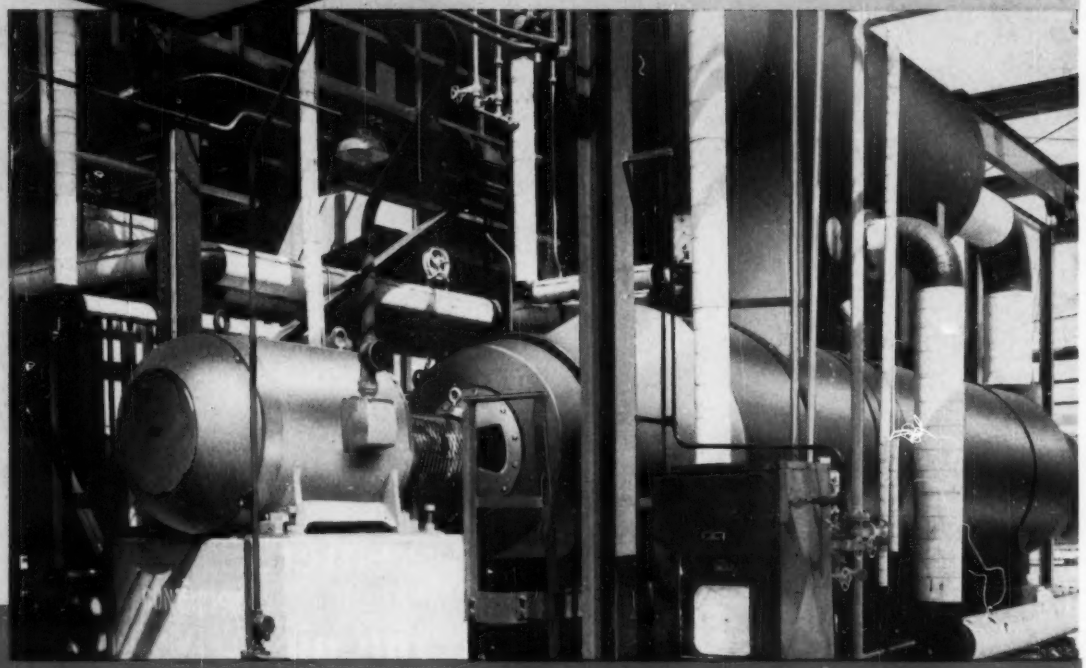
REFINERS CHOOSE

**Effluent Refrigerated**

**STRATCO**

Reg. U. S. Pat. Off.

**ALKYLATION**



***With the Lowest Acid Consumption Record in the Industry***

Recently built Stratco units have established the lowest acid consumption records in the industry. Another characteristic of these new plants is a significant reduction, or in many instances complete elimination, of fractionating column reboiler fouling.

Highest quality alkylate and easiest mechanical operation of Stratco installations are other advantages.

Electronically computed flow diagrams and material balances incorporating these improvements are available quickly and without cost.

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Lester Oberholtz, Los Angeles
Rawson-Houlihan Co., Inc., Houston
The Rawson Co., Inc., Baton Rouge
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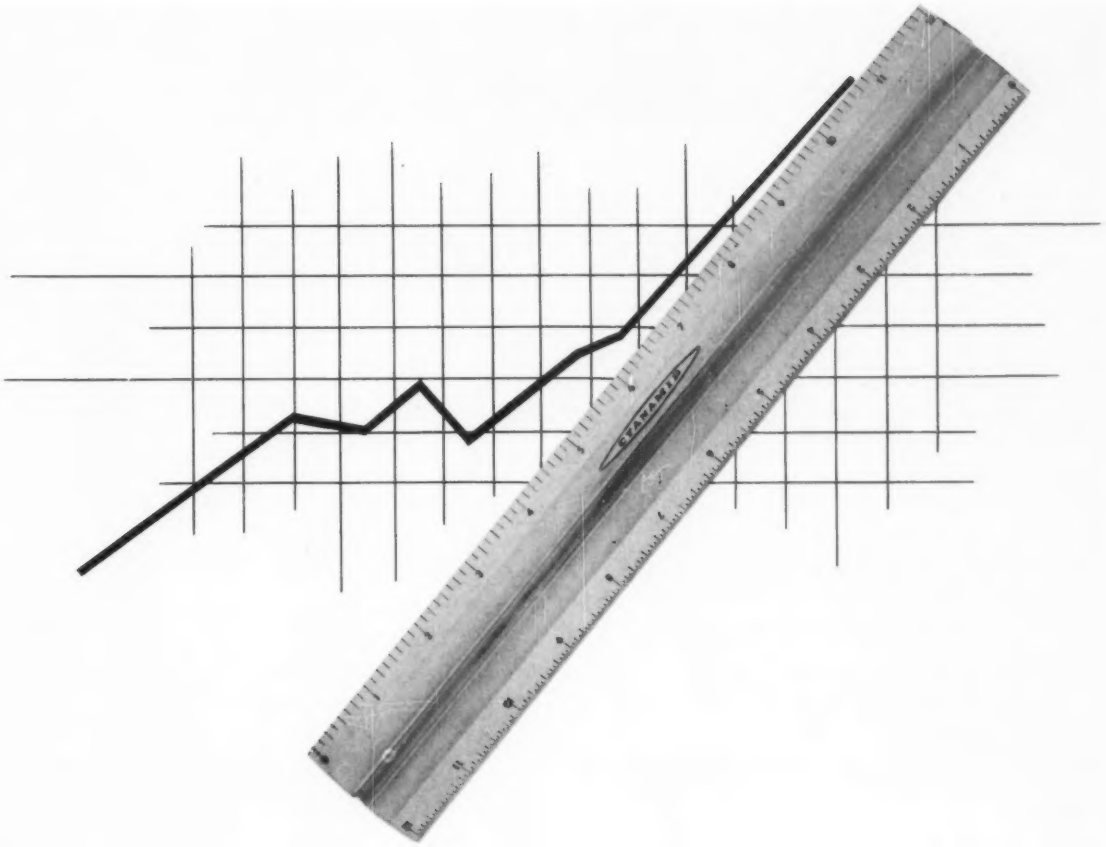
Stratco Effluent Refrigeration licensed by Stratford Engineering Corporation. We cooperate with your contractor in plant design.

**STRATFORD ENGINEERING Corporation**

612 West 47th St. — PETROLEUM REFINING ENGINEERS — Kansas City 12, Mo.



# NOW AEROCAT® 2000 OFFERS A NEW MEASURE OF EFFICIENCY WITH CATALYST ECONOMY

Under certain operating conditions, such as the use of a cracking catalyst at a rate sufficient to reduce the effect of heavy metals, Cyanamid's new AEROCAT® 2000 Fluid Cracking Catalyst provides activity stability with greater economy than other low-cost catalysts.

In addition, AEROCAT 2000 offers these advantages over most other low-cost catalysts:

- *produces higher octanes*
- *has superior attrition resistance*
- *offers more uniform physical and catalytic properties*
- *produces lower coke*
- *has controlled bulk density for better fluidization*
- *has outstanding regeneration properties*
- *shows better selectivity*

AEROCAT 2000 is made under the same controlled conditions by the same modern processes as AEROCAT® Fluid Cracking Catalyst and AEROCAT TRIPLE A® High Alumina Catalyst. It extends Cyanamid's line of cracking catalysts to provide high efficiency products designed to fit *all* operating conditions. For complete information and specifications, see Cyanamid's man with the golden rule.

*Basic in Catalyst Chemistry*

CYANAMID

AMERICAN CYANAMID COMPANY • REFINERY CHEMICALS DEPARTMENT
30 Rockefeller Plaza, New York 20, N. Y.

Originators of AEROCAT® Fluid Cracking Catalysts, AEROCAT TRIPLE A® High Alumina Catalysts, AEROCAT® 2000 Fluid Cracking Catalyst, AEROFORM® Fluid Hydroforming and Platinum Reforming Catalysts, AERO® HDS Catalysts, AERO® Specialty Catalysts, CYPAN® Drilling Mud Conditioner, AEROLUBE® Lubricating Oil Additives, AERONOX® Antioxidants, AEROSOL® Surface Active Agents.



For more data on advertised products, use Readers' Service Cards, last page.

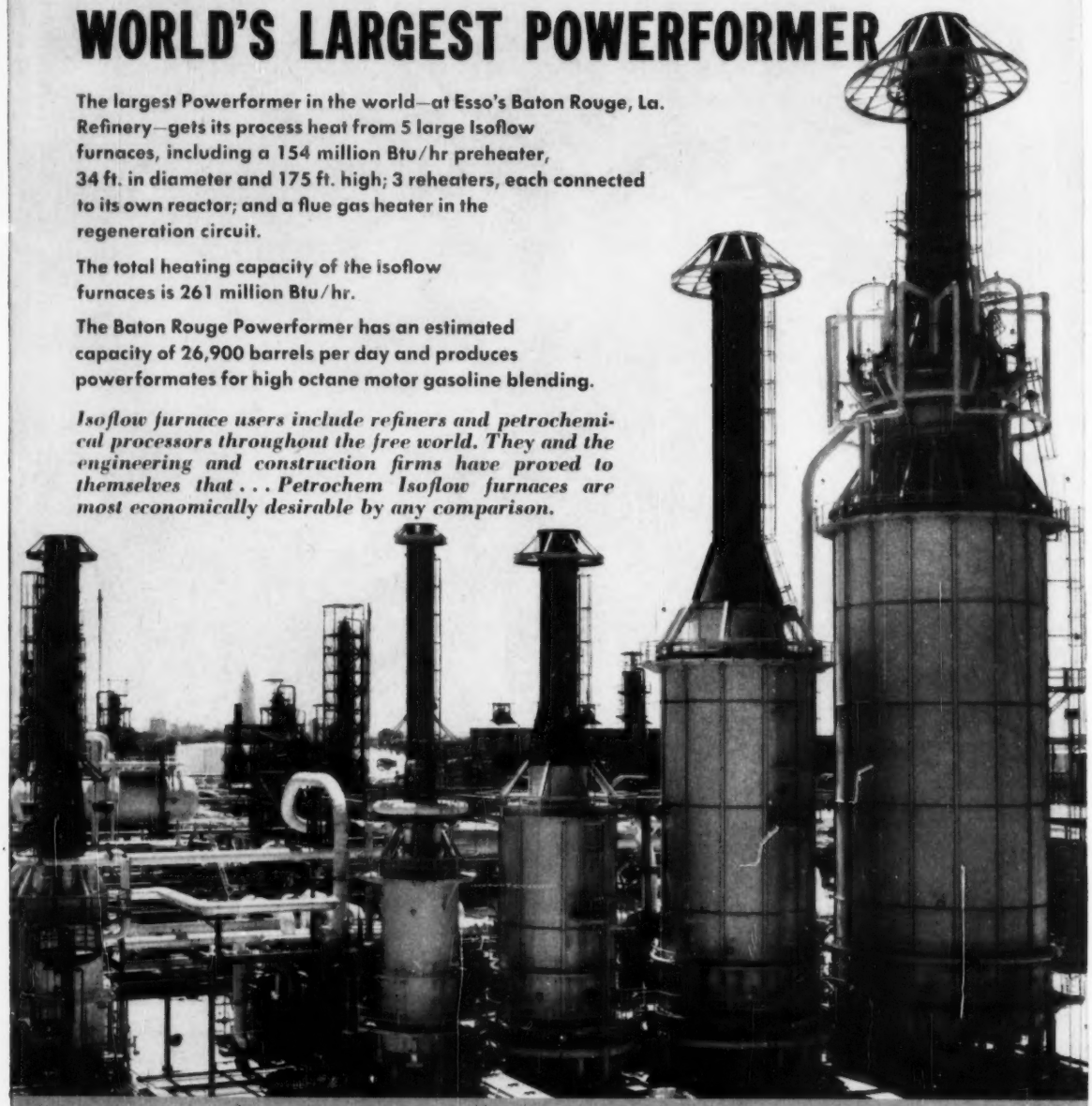
# PETROCHEM-ISOFLOW HEATERS
## *charge*
# WORLD'S LARGEST POWERFORMER

**The largest Powerformer in the world—at Esso's Baton Rouge, La. Refinery—gets its process heat from 5 large Isoflow furnaces, including a 154 million Btu/hr preheater, 34 ft. in diameter and 175 ft. high; 3 reheaters, each connected to its own reactor; and a flue gas heater in the regeneration circuit.**

**The total heating capacity of the isoflow furnaces is 261 million Btu/hr.**

**The Baton Rouge Powerformer has an estimated capacity of 26,900 barrels per day and produces powerformates for high octane motor gasoline blending.**

***Isoflow furnace users include refiners and petrochemical processors throughout the free world. They and the engineering and construction firms have proved to themselves that . . . Petrochem Isoflow furnaces are most economically desirable by any comparison.***

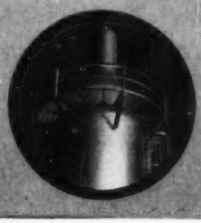


**PETROCHEM-ISOFLOW FURNACES**

UNLIMITED IN SIZE . . . CAPACITY . . . DUTY

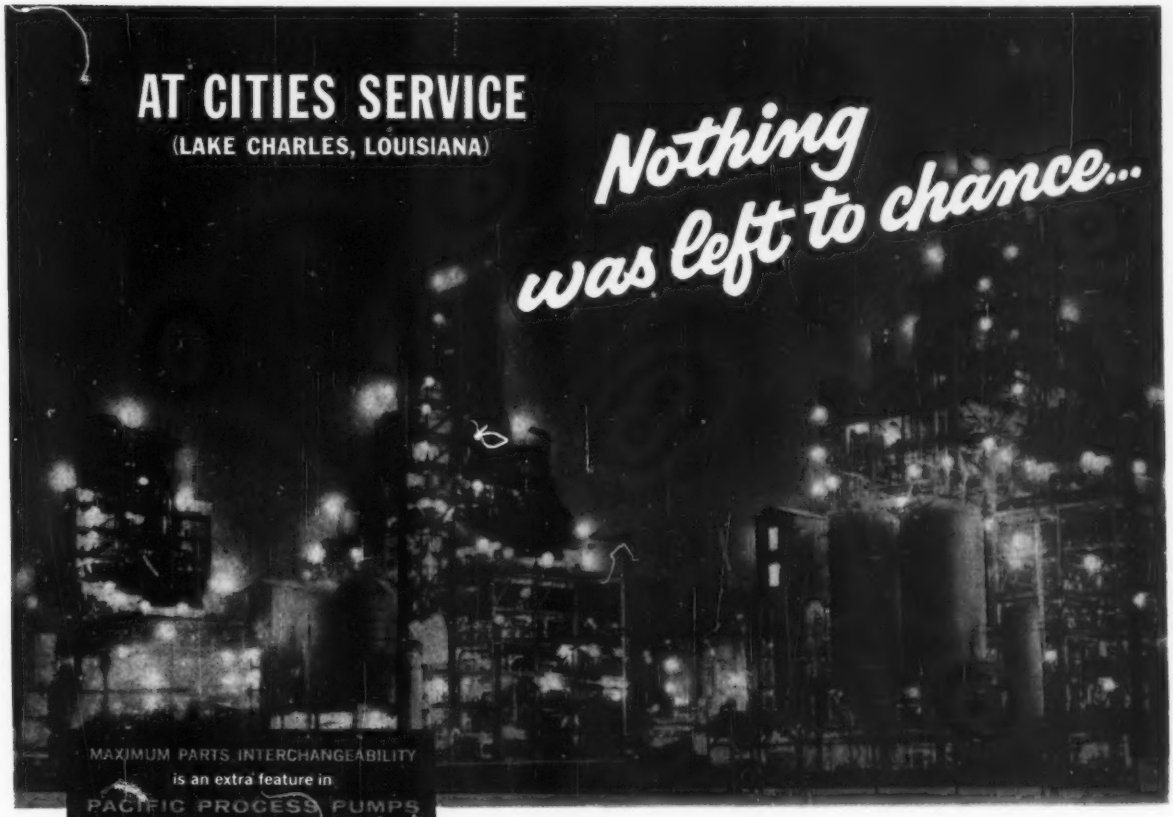
**PETRO-CHEM DEVELOPMENT CO., INC. • 122 EAST 42nd St., New York 17, N. Y.**

REPRESENTATIVES: Rawson Co., Baton Rouge • Rawson-Houlihan Co., Houston • Wm. H. Mason, Tulsa • Lester Oberholtz, Los Angeles • Faville-Levally, Chicago • D. D. Foster, Pittsburgh • Turbex, Philadelphia • Flagg, Brackett & Durgin, Boston G. W. Wallace, Denver, Salt Lake City & El Paso International Licensees and Representatives: Birwelco Ltd., Birmingham, England • Societe Anonyme Heurtey, Paris, France • Societe Anonyme Belge Heurtey, Liege, Belgique • Heurtey Italiana S.P.A., Milan, Italy • Petrochem G.M.B.H., Dortmund, Germany • SETEA-S.A. Comercial, Industrial, y de Estudios Tecnicos, Buenos Aires, Argentina



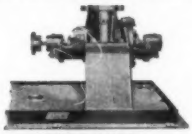



For more data on advertised products, use Readers' Service Cards, last page.

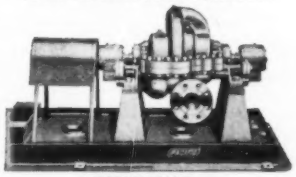



MAXIMUM PARTS INTERCHANGEABILITY
is an extra feature in
PACIFIC PROCESS PUMPS

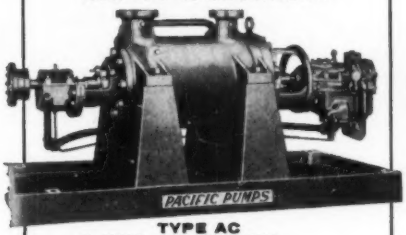
**TYPE SVC**
To 850°F.—25 to 3200 GPM
To 600 PSIG—To 650 DIFF. HD. FT.



**TYPE HVC**
To 850°F.—600 to 4500 GPM
To 600 PSIG—To 1000 DIFF. HD. FT.



**TYPE RHC**
To 500°F.—50 to 3000 GPM
To 700 PSIG—To 1300 DIFF. HD. FT.




**TYPE AC**
To 850°F.—100 to 2500 GPM
To 1000 PSIG—To 2600 DIFF. HD. FT.

## Practically 100% PACIFIC

*process pumps are in service at:*

CITIES SERVICE REFINERY
PETRO-CHEMICAL, INC.
CIT-CON, INC.

The three fluid catalytic crackers illustrated have established new records for continuous operation since going on stream. Under the most demanding service conditions, all three units came through remarkably. Number two unit operated for 1058 consecutive 24-hour days only to be outdone by its sister unit with a record of 1065 days continuous operation. We feel that the 100% Pacific installation (including slurry pumps) contributed to making these run-records possible.

Elsewhere throughout Cities Service, P.C.I. and Cit-Con operations, Pacific process pumps are delivering equally dependable 'round-the-clock service...convincing evidence that "nothing was left to chance."

*Write for Complete Line Bulletin 1C plus individual bulletins for pumps illustrated in panel.*

PACIFIC

**PACIFIC PUMPS INC**
*A Division of Dresser Industries, Inc.*
HUNTINGTON PARK, CALIFORNIA

CP-20



For more data on advertised products, use Readers' Service Cards, last page.

# ALUNDUM* Catalyst Carriers and Supports improve and economize many processes

It will pay you to investigate what many chemical engineers have already discovered — that Norton ALUNDUM catalyst carriers are ideal aids to better, lower cost production in a wide range of processing.

These fused alumina carriers have excellent mechanical, thermal and chemical stability. Crystalline in nature, they are produced in two surface area types: Intermediate (5-70m²/gram) and Low (less than 1m²/gram). Intermediate carriers, subdivided into types A, B and C, have an alumina content of approximately 77%. In the low surface area carriers the alumina content ranges from 77% to 92%.

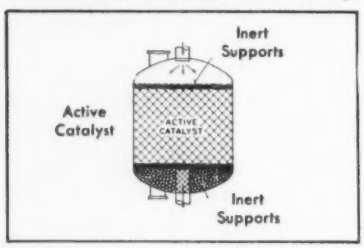
### Some of Many Applications

*For Intermediate Surface Carriers:* catalytic reforming, dehydrogenation, dehydration, sulfuric acid manufacture, nitric acid manufacture and desiccants.

*Low Surface Area Carriers:* processing phthalic anhydride, maleic anhydride and ethylene oxide; also in protective atmospheres and synthetic gas generation.

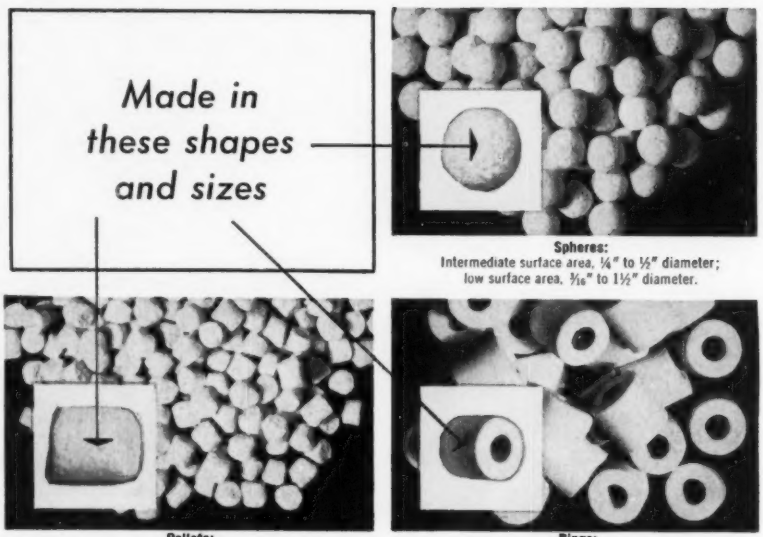
### Catalyst Supports in Fixed Bed Convertors

Where it is necessary to suspend active catalysts at a given level, supports produced by Norton are used successfully. Made of dense, rugged, electrically fused materials, these supports have great resistance to breakdown and have no chemically reactive effect on the processing.




### Get More Facts

on how Norton catalyst carriers and supports can benefit your processing.




**Spheres:**
Intermediate surface area, ¼" to ½" diameter; low surface area, 3/16" to 1½" diameter.

**Pellets:**
All carriers, ⅛" x ⅛" to ½" x ½"

**Rings:**
All carriers (bore length O.D.), ⅛" x ¼" x ⅜" to 1" x 1½" x 1½"

**PHYSICAL PROPERTIES**

| | Apparent Porosity | Water Absorption | Bulk Density | Packing Density | Crystals Present† | Surface Area†† |
|---|---|---|---|---|---|---|
| Intermediate Surface Area Type A ALUMINA | 60-65% | 50-55% | 1.1-1.2 g/cc | 45-50 lbs/ft³ | Predominantly Gamma Alumina. Some Alpha Alumina. Small amount of Quartz. | 60-70m²/gram |
| Type B ALUMINA | 60-65% | 50-55% | 1.1-1.2 g/cc | 45-50 lbs/ft³ | Alpha Alumina. Some evidence of Kappa and Delta Alumina. Small amount of Quartz. | 20-30m²/gram |
| Type C ALUMINA | 60-65% | 50-55% | 1.1-1.2 g/cc | 45-50 lbs/ft³ | Alpha Alumina and Mullite. | 5-10m²/gram |
| Low Surface Area ALUMINA | 10-45% | 3-30% | 1.90-3.15 g/cc | 60-110 lbs/ft³ | Alpha Alumina and Mullite. | Less than 1m²/gram |

†By X-Ray Analysis ††BET Method

On request they can be prepared from other materials, including CRYSTOLON* silicon carbide, MAGNORITE* fused magnesia, zirconium oxide, zircon, silica, etc. Call on your Norton Refractories Engineer or write for Bulletin No. 7 to NORTON COMPANY, Refractories Division, 460 New Bond Street, Worcester 6, Mass.

NORTON
REFRACTORIES
*Engineered... Rx ...Prescribed*

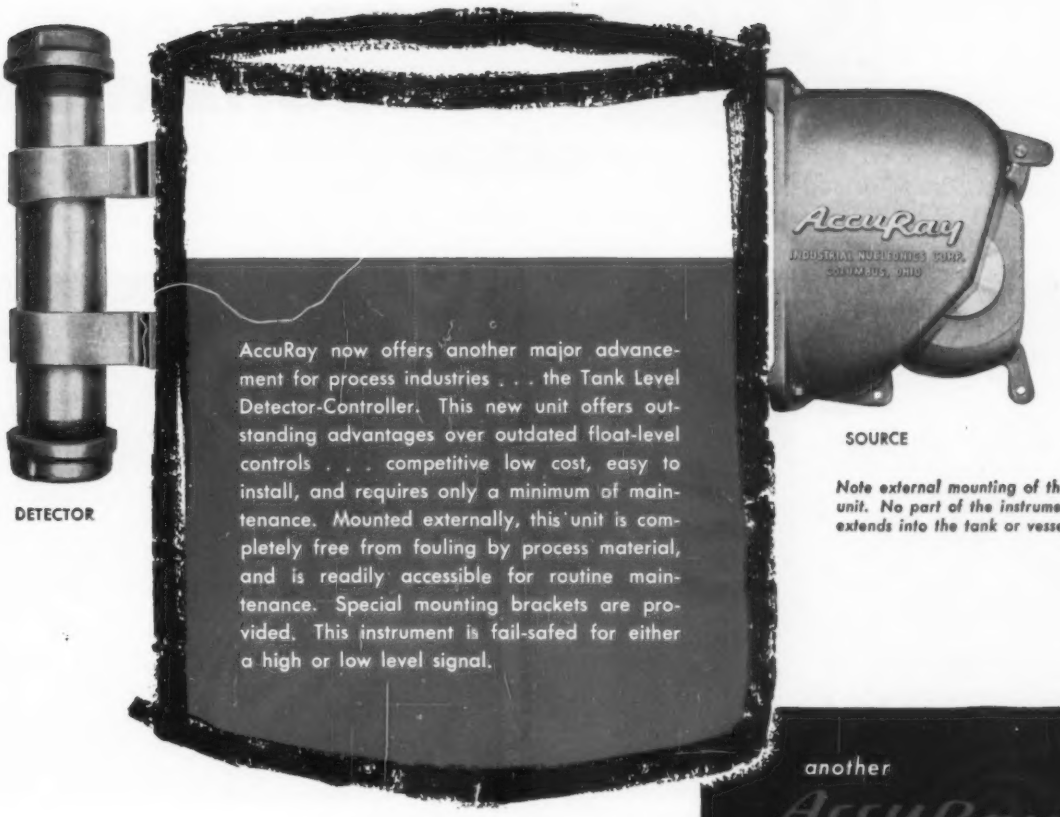
*Trade-Marks Reg. U.S. Pat. Off. and Foreign Countries

**Making better products . . . to make your products better**

**NORTON PRODUCTS** Abrasives • Grinding Wheels • Grinding Machines • Refractories • Electrochemicals — **BEHR-MANNING DIVISION** Coated Abrasives • Sharpening Stones • Pressure-Sensitive Tapes

# plan for the future

## AccuRay® TANK LEVEL DETECTOR-CONTROLLER




DETECTOR

SOURCE

*Note external mounting of the unit. No part of the instrument extends into the tank or vessel.*

AccuRay now offers another major advancement for process industries . . . the Tank Level Detector-Controller. This new unit offers outstanding advantages over outdated float-level controls . . . competitive low cost, easy to install, and requires only a minimum of maintenance. Mounted externally, this unit is completely free from fouling by process material, and is readily accessible for routine maintenance. Special mounting brackets are provided. This instrument is fail-safed for either a high or low level signal.

another AccuRay® advancement for process control

The new AccuRay tank level detector-controller is unequaled for accuracy and reliability. The system will reduce maintenance costs and increase efficiency, resulting in higher profits for the petroleum industry. Adaptable to four methods of operation—high or low level control, narrow band control, wide band control, and extra-wide band control—this low-cost system is designed in accordance with accepted standards for both explosion-proof and weather-proof operation.
Also available is the continuous tank level system. Continuous indication of the level of material is read directly from a meter or recorder. Both systems can play an important part in your modernization plans.

*® AccuRay is a Registered Trademark of Industrial Nucleonics Corporation*

**Industrial Nucleonics**
CORPORATION
1169 Chesapeake Ave. • Columbus 12, Ohio

Please send complete details on AccuRay Tank Level Detector-Controllers.

Name ..... Title .....

Company .....

Street .....

City ..... Zone ..... State .....

Application .....

.....

**The WORLD'S LARGEST Manufacturer of Nucleonic Industrial Process Control Systems**



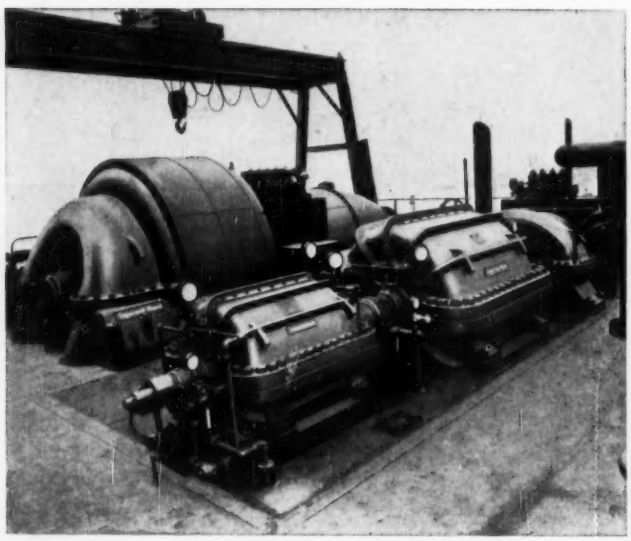
For more data on advertised products, use Readers' Service Cards, last page.

*Behind this symbol*

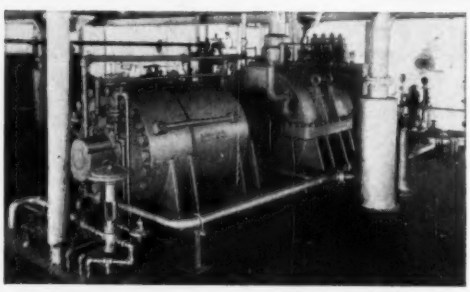
...a century of service

*Here's what it means to*

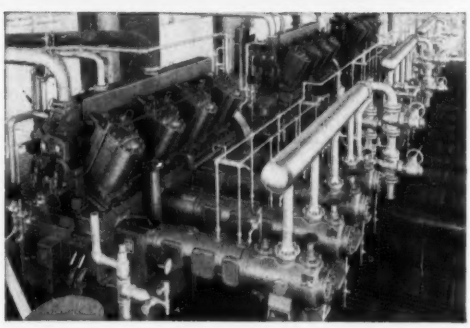
# REFINERY and PETROCHEMICAL MEN...



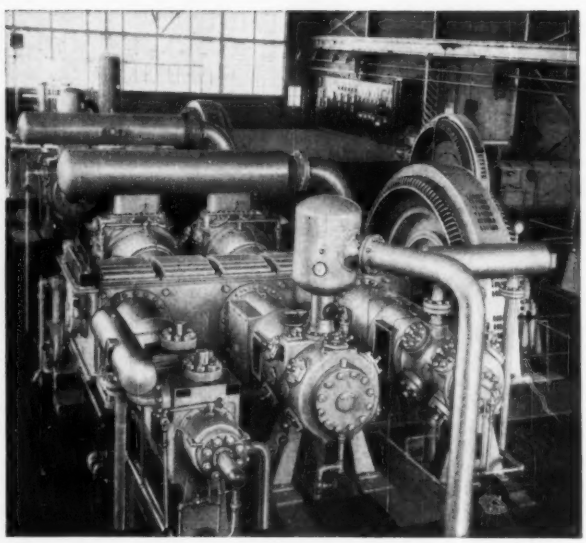
I-R cat-cracking Turbo-Blower rated 122,700 cfm (in background), and two I-R centrifugal compressors in series-tandem rated 20,800 cfm. They are powered by I-R steam turbines, rated 10,000 hp and 6500 hp respectively.



This Ingersoll-Rand vertically-split centrifugal compressor, handling hydrogen at 675 psi, is driven by an I-R steam turbine rated 5500 hp.



Three 440-hp SVG-NL gas-engine compressors with non-lubricated compressor cylinders recycling hydrogen. Ingersoll-Rand builds 4-cycle, V-angle engine-compressors from 120 to 2000 hp.



This ammonia synthesis plant has nine multi-stage HHE process compressors totalling 15,100 hp. I-R electric-driven reciprocating compressors range from ½ to 7500 hp.

## Compressors for every job

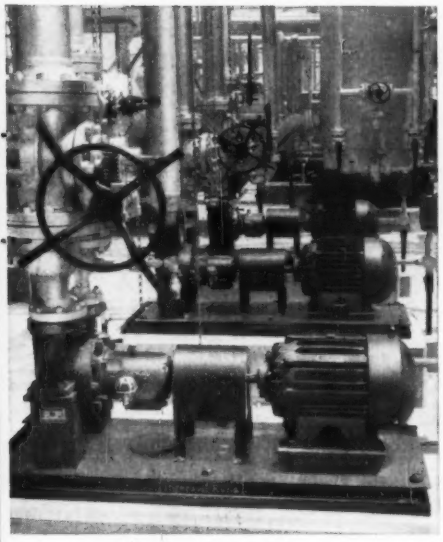
Ingersoll-Rand has the world's most comprehensive compressor experience, and builds reciprocating, centrifugal, rotary and jet types in all sizes. Reciprocating units are available in sizes for ½ to 7500 hp, for pressures from vacuums to 35,000 psi. Centrifugal compressors and Turbo-Blowers are offered for pressures to 5000 psi and higher, and capacities to 400,000 cfm. I-R also builds steam turbines to 20,000 hp and higher for a wide range of steam conditions and speeds.




For more data on advertised products, use Readers' Service Cards, last page.

# to the oil industry:

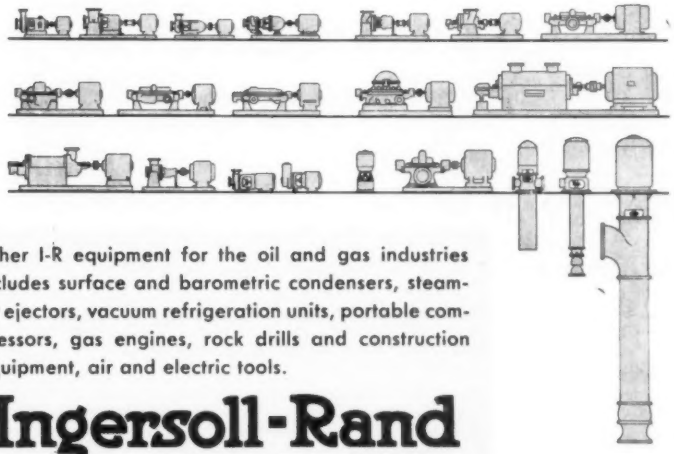
Soon after Colonel Drake discovered oil at Titusville, the history of Ingersoll-Rand began with the manufacture of Cameron reciprocating steam pumps. A few years later, other I-R "ancestor" companies began building compressors and rock drills. Ever since that time Ingersoll-Rand has been growing with the oil and gas industries. Today I-R provides the widest range of compressors, pumps and other equipment for the production, transmission, and processing of oil and gas and their products—the I-R monogram is more than ever a symbol of leadership and progress.



## Centrifugal pumps for every service

Ingersoll-Rand offers the most complete line of centrifugal pumps available from any single manufacturer (capacities to 140,000 gpm, total heads to 6500 ft., sizes to 23,000 hp.) There is a size and type to meet the exact requirements of any process application to best advantage. Sustained high efficiency and maximum interchangeability of parts contribute to low operating and maintenance costs.

Photo shows three vertically-split process pumps on debutanizer service. Below are a few of the hundreds of types and sizes of centrifugal pumps built by Ingersoll-Rand.

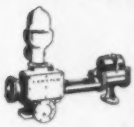


Other I-R equipment for the oil and gas industries includes surface and barometric condensers, steam-jet ejectors, vacuum refrigeration units, portable compressors, gas engines, rock drills and construction equipment, air and electric tools.

**Ingersoll-Rand**

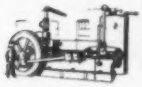
14-883 11 Broadway, New York 4, N.Y.

### I-R MILESTONES OF PROGRESS
*have had a far-reaching effect on the petroleum industry*



**1860** The first Cameron pump—a reciprocating steam pump which found wide use in the petroleum industry.

**1871** Simon Ingersoll's steam-powered rock drill.



**1872** Heavy-duty reciprocating compressors.

**1902** The first portable compressor.

**1906** The first direct-connected synchronous-motor-driven compressor.

**1912** First centrifugal compressor for 90-psi air, and powered by I-R turbine.

**1913** Centrifugal pump.

**1920** Oil-engine compressor engineered as a unit; solid fuel injection.

**1924** Large 4500-psi compressors for ammonia synthesis (still operating).

**1927** Centrifugal pipeline pump; mechanical shaft seal.

**1928** Barrel-type hot-oil charging pump for refineries.

**1930** First compressor for 15,000 psi on commercial scale.

**1931** Close-coupled Motorpump.

**1931** First centrifugal gas pipeline compressor, "canned" with 3000-hp motor.

**1933** Famous XVG gas-engine compressors combined multiple power cylinders and compressor cylinders on single frame.

**1933** First non-lubricated compressors.

**1935** Channel Valves set new standards for compressor valving, unmatched to this day.

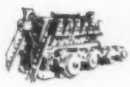
**1937** Complete line of vertically-split centrifugal process pumps.

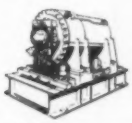
**1940** First fluid cat-cracker main air blower.

**1947** First high-pressure centrifugal compressor for gas transmission.

**1949** First centrifugal gas compressor for cat-cracking.

**1952** First turbo-charged gas-engine compressor, the 2000-hp KVS.





**1954** First centrifugal compressor for 2000 psi.

**1955** Compressor built for 35,000 psi on commercial scale.

**1958** Highest-pressure centrifugal pump —6500 psi.

**In engineered products, there's no substitute for experience**

# YOU CAN BUY THESE 9 CATALYSTS FROM A SINGLE SOURCE!

Stauffer is a major source of metal chlorides and other catalysts widely used in the Petroleum and Chemical industries. Wide distribution of manufacturing and warehouse facilities assures a continuous, dependable and *flexible* source . . . a *single* source for all these important catalysts.

## STAUFFER CHEMICAL COMPANY

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Stauffer CHEMICALS SINCE 1885

**ALUMINUM TRICHLORIDE** — Various mesh sizes in drums of 50 to 600 pounds net, and in bulk. Also in solution.

**ANTIMONY CHLORIDES** — Both solid and flake (anhydrous) in drums of 25 to 700 pounds net. Liquid pentachloride in drums of 25 to 700 pounds net, in tank trucks and tank cars.

**BORON TRICHLORIDE** — In low-pressure cylinders of 100 and 1800 pounds net; also in tank cars. 6-pound cylinders for experimental use.

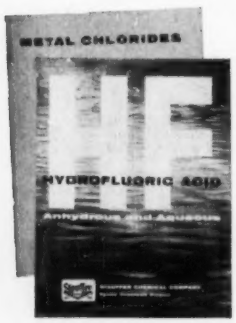
**HYDROCHLORIC ACID** — Anhydrous HCl available in tube trailers or cylinders from Los Angeles, Calif., and Fort Worth, Texas.

**HYDROFLUORIC ACID** — Anhydrous HF available in tank cars of 22- and 42-ton capacity, and in 100- and 200-pound cylinders, from Stauffer's Nyotex Chemicals Division at Houston; aqueous acid in drums and tank cars from Louisville.

**SULFURIC ACID** — Commercial grades at concentrations of 77.67% up to 122.5%. Oleum at various strengths from 15 to 65% free $SO_3$; also liquid $SO_3$. By pipeline, barges, tank cars and tank trucks from factories at Mobile, Ala.; Los Angeles and Richmond, Calif.; Hammond, Ind.; Baton Rouge, La.; Baytown, Fort Worth and Houston, Tex., and various stock points.

**TITANIUM TETRACHLORIDE** — Technical and C. P. Tank cars and tank trucks; 10-gallon and 55-gallon drums of 130 and 725 pounds net from Niagara Falls, New York.

**TITANIUM TRICHLORIDE (Anhydrous)** — Available in 1-, 5- and 55-gallon drums packaged under argon atmosphere f. o. b. Richmond, Calif.




## LITERATURE AVAILABLE

**METAL CHLORIDES:**

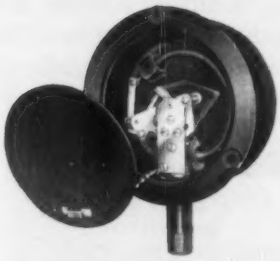
Send for copy of a new and authoritative book on Metal Chlorides. There are sections on chlorides of silicon and zirconium in addition to those described above.

**HYDROFLUORIC ACID:**

16-page brochure with many graphs and tables and a 24-page pocket-size booklet on Safe Handling and Analytical Methods.

# Do you know All the facts on All these USG instruments for the petroleum industry?

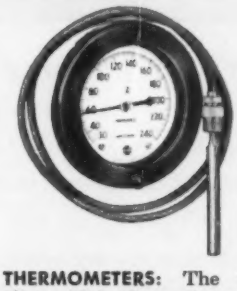
**PROCESS GAUGES:** The SUPERGAUGE line for pressure or vacuum. Rugged and accurate—equal or exceed ASA Grade AA specifications. Iron, aluminum, or phenolic cases; easy to recalibrate; stainless steel or stainless steel-and-nylon movements; specially suited for corrosive conditions. Ranges to 20,000 psi. Write for Catalog 1819.



**SOLID FRONT GAUGES:** The SOLFRUNT line which parallels the SUPERGAUGE line in essential specifications but has the solid front safety feature. Standard SOLFRUNT gauges are cast aluminum with integrally cast solid front wall and safety blowout back seal. Write for Catalog 1819.

**GENERAL "UTILITY" GAUGES:** The USG A-Line for numerous applications requiring a rugged, lower cost gauge for air, gas, steam, oil, refrigeration, hydraulic or ammonia systems. Equal or exceed ASA Grade A specifications. Industrial gauges with alarms and pressure switches also available. Write for Catalog 305.

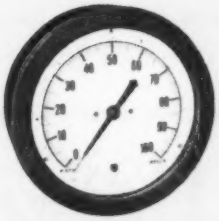
**TEST GAUGES:** Equal or exceed ASA grade AA requirements, with guaranteed accuracies within ½ of 1% of indicated reading in 12 and 16-inch laboratory models; ¼ of 1% of scale on 4½, 6, and 8½-inch types for test stands etc. Also available in 3-inch portable design for field testing. Write for Catalog 400.



**DIAL THERMOMETERS:** The SUPERTHERM line with both remote and direct reading types of filled-system thermometers. For temperatures from −350 to +1000 F. Mercury, vapor, gas, or organic liquid fills. Phenolic or aluminum cases that match SUPERGAUGE line in appearance. Large selection of bulbs, capillaries, and connections. Write for Catalog 205.

**PNEUMATIC CONTROLLERS:** The compact, low cost USG "PILOT" that indicates and controls temperature or pressure. Mounts on wall, panel, or control valve. Available with wide band proportional control and automatic reset or rate action. Options: 4-position by-pass; index setting with mechanical limit stops. Write for Catalog 510.

**PNEUMATIC TRANSMITTERS:** The USG line of indicating transmitters for temperature, pressure or other variables. Case matches Pilot line, measuring 8½ inches square. Output signal: 3 to 15 psi standard; others available. Sensitivity: within 0.1% of scale with high accuracy and repeatability. Has 3½-inch indicating dial (6¾-inch scale length). Write for Catalog 510.



**PNEUMATIC RECEIVERS:** USG offers a complete line of indicating receivers. Diaphragm actuated gauges, 4½ to 16 inches, have accuracy of 0.25% of scale, in single or duplex pointer styles. Rugged Bourdon tube types also available. Receivers reading at "12 o'clock" also offered, so that normal indications of adjacent gauges can be easily compared. Write for Catalog 510.

**RECORDERS AND RECORDER CONTROLLERS:** The USG line of thermometer and pressure recorders with 6, 9, or 12-inch circular charts. All four fills for temperatures from −350 to +1000 F. Pressures to 25,000 psi. Portable recorders also. Pneumatic or electric contact control offered too. Write for Catalog 456A.

Call your nearest USG Distributor. Let him bring you up-to-date on the latest process instrument developments from U.S. Gauge.

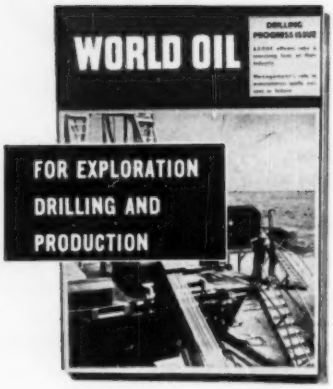
**UNITED STATES GAUGE**

Division of American Machine and Metals, Inc. • Sellersville, Pa.

USG

# HOW GULF PUBLISHING COMPANY SERVES

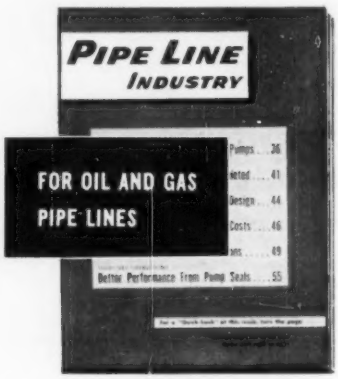
**Specialized Monthly Petroleum Publications**—Over a period of 43 years, Gulf Publishing Company's name has become a symbol for specialized petroleum industry publications. Those pictured on this page are issued for each of the three specialized oil industry operating divisions—Drilling-Production, Pipe Line and Refining.




**WORLD OIL** is the "idea" magazine of the oil fields. It's a monthly how-to-do-it publication, featuring engineering-operating articles.

Sectionalized for quick reading, WORLD OIL's editorial content is geared to the Drilling-Production Division of the Oil Industry.

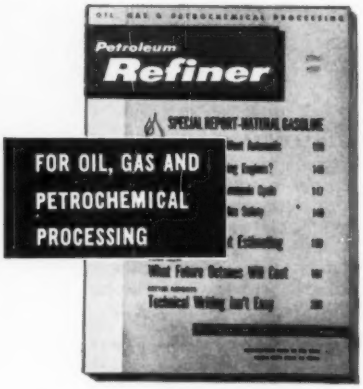
Oil men like it, because it is specialized, written for industry men by industry men. WORLD OIL is the leading publication among men directly engaged in exploration, drilling, production activities. Subscribers like it. Advertisers like it.




**PIPE LINE INDUSTRY** is designed and edited to serve the specialized pipe line division of the industry. Expanding a new concept in editorial service, this publication each month offers coverage of construction, operations and maintenance.

Job-help articles by industry experts stress new developments, efficient use of equipment, latest engineering-operating features.

Reading material is specialized for the Pipe Line Division of the industry, is written specifically for pipe line men.




**PETROLEUM REFINER** is as specialized as the division of the industry it covers. For 37 years it has been the work book of oil, gas and petrochemical processing men.

Editorial policy is keyed to the presentation of ever-changing technology so necessary for progress in the industry. Engineering-operation features give data that can be used right on the job.

PETROLEUM REFINER is so helpful that it has the highest circulation among men directly engaged in this division of the industry.

Another Service

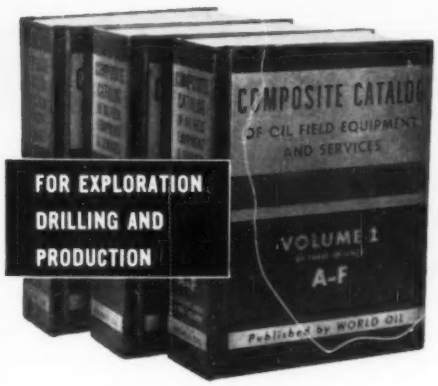
**OIL INDUSTRY BOOKS**

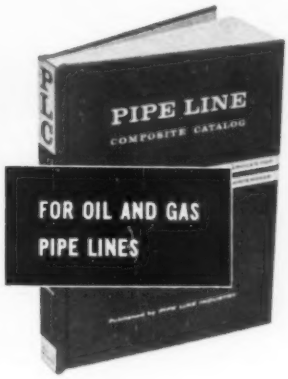
Gulf Publishing Company also offers technical, job-help books for use by men in the Petroleum Industry. For complete information, send for FREE catalog describing hundreds of books available through Gulf Publishing Company. Write to Petroleum Books Dept., P. O. Box 2608, Houston 1, Texas.

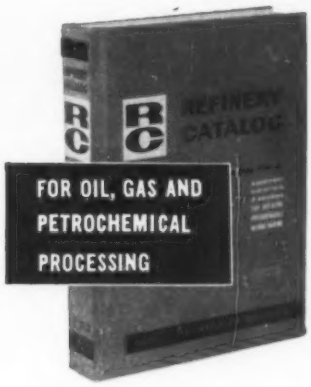
If you work in these oil industries, or if you sell products and services to them, Gulf Publishing Company specialized publications can be of help to you. Individually they perform specialized services for each of the industry divisions they represent. For further details, contact any of our branch offices.

# THE SPECIALIZED OIL INDUSTRIES . . .

**Specialized Petroleum Industry Catalogs**—If you buy for or sell to the Petroleum Industry markets, you need adequate catalog data. Here are Gulf Publishing Company's three specialized oil industry pre-filed catalogs. Like the publications pictured on the opposite page, the catalogs are symbolic of the service Gulf Publishing has provided this industry for 43 years.




For 30 years COMPOSITE CATALOG OF OIL FIELD EQUIPMENT AND SERVICES has been serving the Drilling-Production Division of the Industry.

Used all over the world, this current catalog has 5,384 pages from more than 500 different companies selling to this industry. It is indexed and cross-indexed for easy reference.

Published every 18 months, it has detailed data on every type of Drilling and Production Equipment. It is the largest and most complete composite catalog ever published for this industry (or many others).

Gulf Publishing Company in 1957 began the publication of a new, specialized PIPE LINE COMPOSITE CATALOG. This catalog goes to men having actual buying and specifying authority in pipe line companies, gas transmission companies, pipe line contractors and engineering-design concerns. It is published every 18 months.

The PIPE LINE COMPOSITE CATALOG has 540 pages of complete or condensed catalog information from 169 leading suppliers to this division of the industry. It is serving as a genuine time saver for pipe line men with buying and specifying authority.

The REFINERY CATALOG contains the complete or condensed catalogs of almost 300 manufacturers and service companies selling to the Refining Division of the Industry. This information is contained in a 1,000-page annual volume.

For 26 years, REFINERY CATALOG has been the preferred source of buying information for Oil, Gas and Petrochemical Processing men with purchasing authority. It makes equipment and services easier to buy, easier to sell.

Completely indexed by products and services, the REFINERY CATALOG is a useful on-the-job tool.

Gulf Publishing Company composite catalog files perform a specialized service for each division of the Petroleum Industry they serve. They perform an unduplicated service to the oil men, are used right on the job.

# GULF PUBLISHING COMPANY

***WORLD'S LARGEST SPECIALIZED OIL INDUSTRY PUBLISHERS***

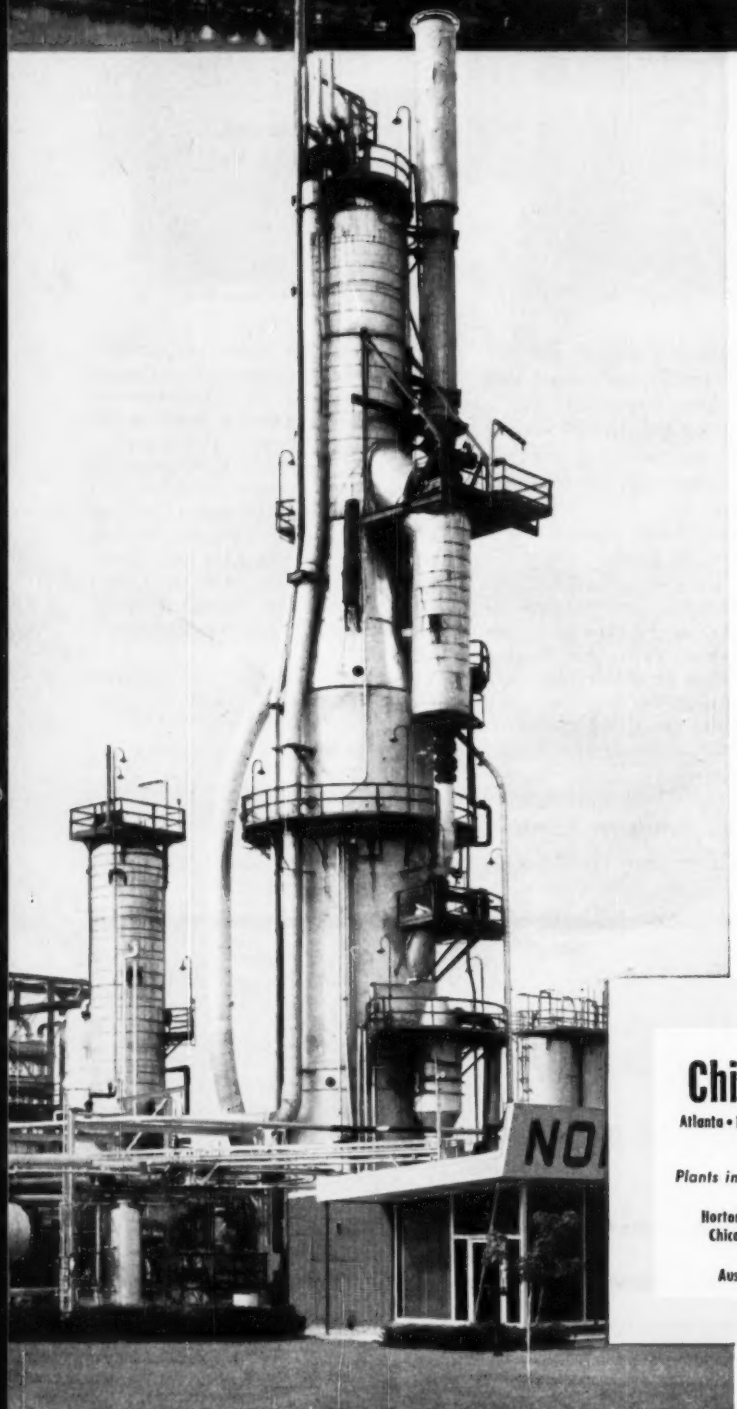
**OFFICES: Houston, New York, Chicago, Cleveland, Dallas, Tulsa, Los Angeles, London, Hannover.**



For more data on advertised products, use Readers' Service Cards, last page.

# 20 CB&I STRUCTURES

## serve refinery expansion at Twin Cities



### CB&I tanks and towers keep pace with NORTHWESTERN growth

Over the past 10 years CB&I has built storage tanks for nearly 900,000 barrels of crude oil and petroleum products for the fast-growing Northwestern Refining Co. of St. Paul Park, Minnesota. CB&I also built the reactor-regenerator for the refinery's modern UOP cracking unit, shown at left.

Long-term CB&I customers can plan refinery expansion with confidence that CB&I-built structures will meet their continuing demand for progress and perfection. A single responsibility for engineering, fabrication, metallurgical and erection detail—*CB&I craftsmanship in steel*—means that CB&I storage and processing structures provide greater efficiency and maximum service life.

This is why so many CB&I customers are *repeat* customers. Write our nearest office for the bulletin: *CB&I Special Plate Structures.*

**Top:** CB&I-built storage tanks at Northwestern include 80,000 bbl. Horton® Floating Roof crude oil tanks and jet fuel storage tanks.

**Left:** UOP Cat Cracker at Northwestern includes CB&I-built 10-ft. diam. reactor, 16½-ft. diam. regenerator.

## Chicago Bridge & Iron Company

Atlanta • Birmingham • Boston • Chicago • Cleveland • Detroit • Houston • Kansas City (Mo.)
New Orleans • New York • Philadelphia • Pittsburgh • Salt Lake City
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*Plants in* Birmingham • Chicago • Salt Lake City • Greenville, Pa. • New Castle, Delaware

SUBSIDIARIES:
Horton Steel Works Limited, Toronto; Chicago Bridge & Iron Company Ltd., Caracas; Chicago Bridge Limited, London; Chicago Bridge Construcoes Ltda., Rio de Janeiro

REPRESENTATIVES AND LICENSEES:
Australia, Cuba, England, France, Germany, Italy, Japan, Netherlands, Scotland

P75CB

## Ask Your *FISHER/MAN* How To

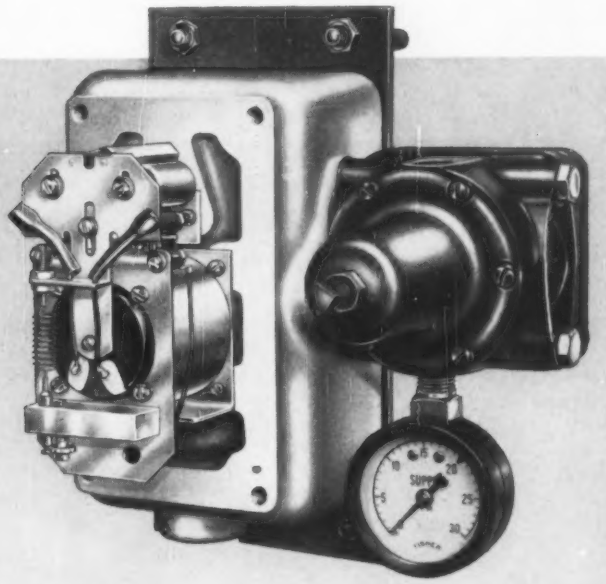
# SPEED THE INPUT SIGNAL to the CONTROL VALVE

**FISHER**

**TYPE**

# 543

**ELECTRO PNEUMATIC TRANSDUCER**



## Available with or without a pneumatic valve positioner

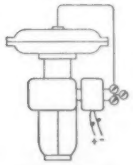
Here's an electro-pneumatic transducer developed for use in electrical control loops where the final control element is pneumatically operated. Explosion proof design makes it ideal for use under hazardous conditions. Input signals may range from 1 to 5 ma. through 10 to 50 ma.... output from 3 to 15 psi through 6 to 30 psi. Built-in volume relay permits direct operation of the pneumatic actuator from the Transducer. No extra relays or boosters needed. Relay can be serviced independent of electrical assembly. Unit is completely reversible by reversing input leads and rezeroing.

If you want additional information on the Type 543 Electro-Pneumatic Transducer write Fisher Governor Company.

| TYPICAL CIRCUITS | | |
|---|---|---|
| Input Current | Load Requirements of Controller | Actual Internal Resistance of Transducer |
| 1 to 5 ma dc | 3,000 ohms maximum | 2,500 ohms ±125 ohms |
| 1 to 5 ma dc | 12,000 ohms ± .5% | 12,000 ohms ± 50 ohms |
| 10 to 50 ma dc | 500 ohms maximum | 57 ohms ± 4 ohms |

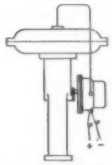
| PERFORMANCE DATA | |
|---|---|
| Linearity | 1% of full range |
| Air Consumption Rate | 2 SCFH with 15 psi output pressure |
| Resolution Sensitivity | .05% of input range |
| Frequency Response | Complete frequency response data with Fisher topworks available |

TYPE 3541



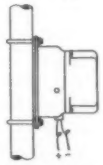
Electro Pneumatic Controller Mounted on Control Valve

TYPE 543



Transducer Mounted on Control Valve

TYPE 543



Transducer Mounted on Stand Pipe

IF IT FLOWS THROUGH PIPE ANYWHERE IN THE WORLD... CHANCES ARE IT'S CONTROLLED BY...

**FISHER GOVERNOR COMPANY**

*Marshalltown, Iowa / Woodstock, Ontario / London, England*

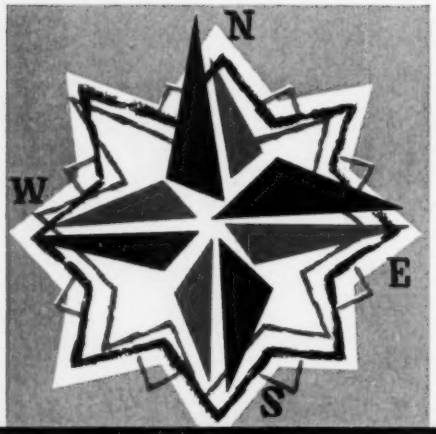
CONTINENTAL EQUIPMENT CO. DIVISION, Coraopolis, Pennsylvania

FISHER® Controls

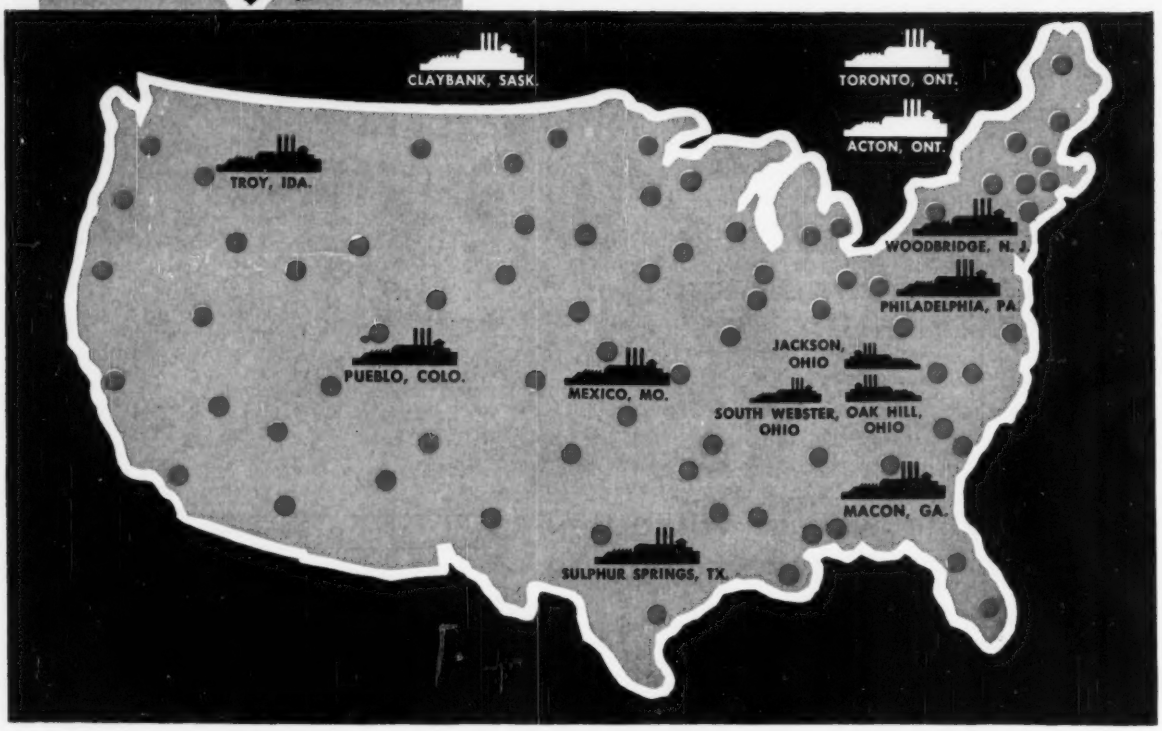
*SINCE 1880*



For more data on advertised products, use Readers' Service Cards, last page.




## A. P. GREEN PLANTS and warehouse stocks conveniently located to save you down time and shipping costs




Manufacturing Plants

Warehouse stocks in principal cities

**Your A. P. Green Distributor is Listed In The Yellow Pages of Your Telephone Directory, or write:**

**A. P. GREEN FIRE BRICK COMPANY**
Mexico, Missouri, U. S. A.

A. P. Green REFRACTORY PRODUCTS

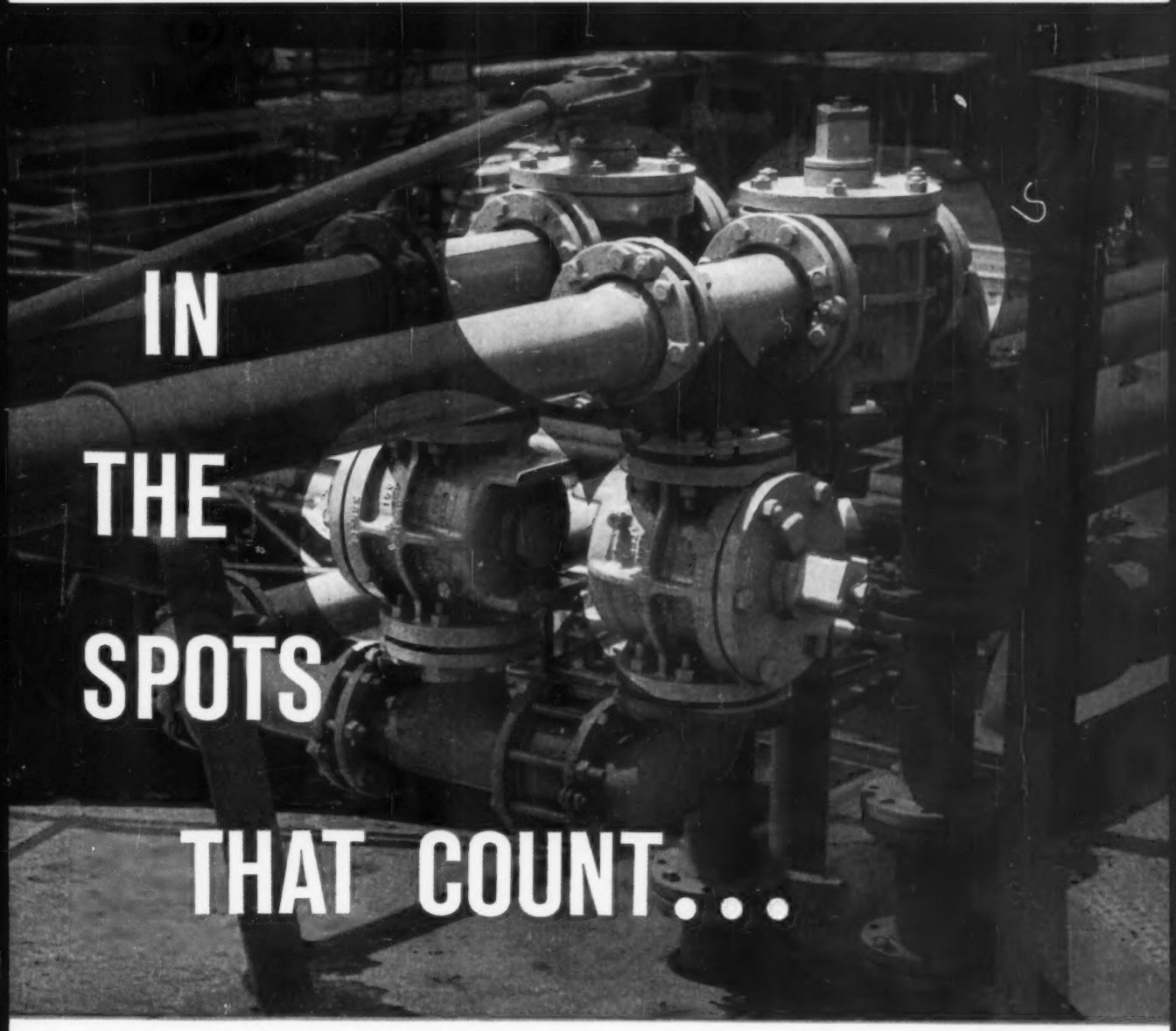
**PLANTS:** Mexico, Mo. — Woodbridge, N. J. — Sulphur Springs, Texas — Jackson, Oak Hill, South Webster, Ohio — Philadelphia, Pa. — Troy, Idaho — Pueblo, Colo. — Macon, Ga.

**IN CANADA:**
A. P. Green Fire Brick Company, Ltd., Toronto 15, Ontario.

**13 A. P. Green manufacturing plants and warehouse stocks conveniently located throughout the United States and Canada, Save You Money 7 Ways.**

- **Lower Shipping Costs . . . from nearby manufacturing or warehouse point.**
- **Lower Capital Investment . . . your capital is not tied up in warehouse space.**
- **Lower Inventory Costs . . . you need inventory only for *immediate* needs.**
- **Lower Inventory Losses . . . buy on current prices . . . less breakage while in storage.**
- **Increase Production Space . . . free storage space for profitable production.**
- **Lower Labor Costs . . . deliveries to point of usage . . . no inplant moving of stocks.**
- **Maintain Steady Production . . . reduce down time waiting for materials.**

***Distributors In The Principal Cities of the World***




## Goodyear specifies Homestead Valves for non-contamination of GR-S latex rubber

Through the round ports of Homestead Lubricated Plug Valves at Goodyear Tire and Rubber Company's synthetic rubber plant in Houston, Texas, flow dilute solutions of GR-S latex rubber at 80 p.s.i. and 100° F.

Fluid solutions never lodge and build up in the line since Homestead Round Port Valves provide full circular opening through plug and body of the valve —same size as the pipe they serve.

A letter or the coupon below will bring you further information on this installation. You may also receive complete details on low first cost, low maintenance, Homestead Valves in our catalog 39-1.

Controlled pressurized lubrication plus extremely close tolerances between plug and body assure lubrication of all sealing surfaces without contamination of line fluids.

hv

**HOMESTEAD VALVE MANUFACTURING COMPANY**
P. O. Box 45, Coraopolis, Pennsylvania

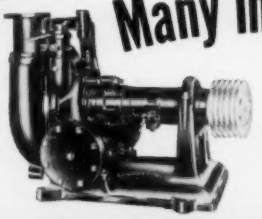
☐ Please send me catalog and prices on Homestead Lubricated Plug Valves.
☐ Send more facts about latex applications.

Name ..... Title .....

Company .....

Address .....

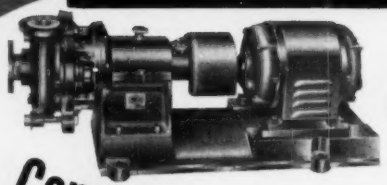
City ..... Zone ..... State .....



Many Industrial Plants Use Both

SAND PUMPS

WILFLEY



ACID PUMPS

Companions in Economical Operation

Industrial operations requiring both sand pumps and acid pumps are increasing almost daily. And now, more than ever before, efficient, low-cost pumping is a prime consideration. For this reason many plant operators choose the Wilfley team. They know Wilfley sand pumps and acid pumps consistently increase production and reduce operating costs. Wilfley's long-standing record of day-in, day-out dependability is a record *you* can rely on. Put Wilfley pumps to work now . . . every installation is job engineered to give you maximum efficiency and economy.

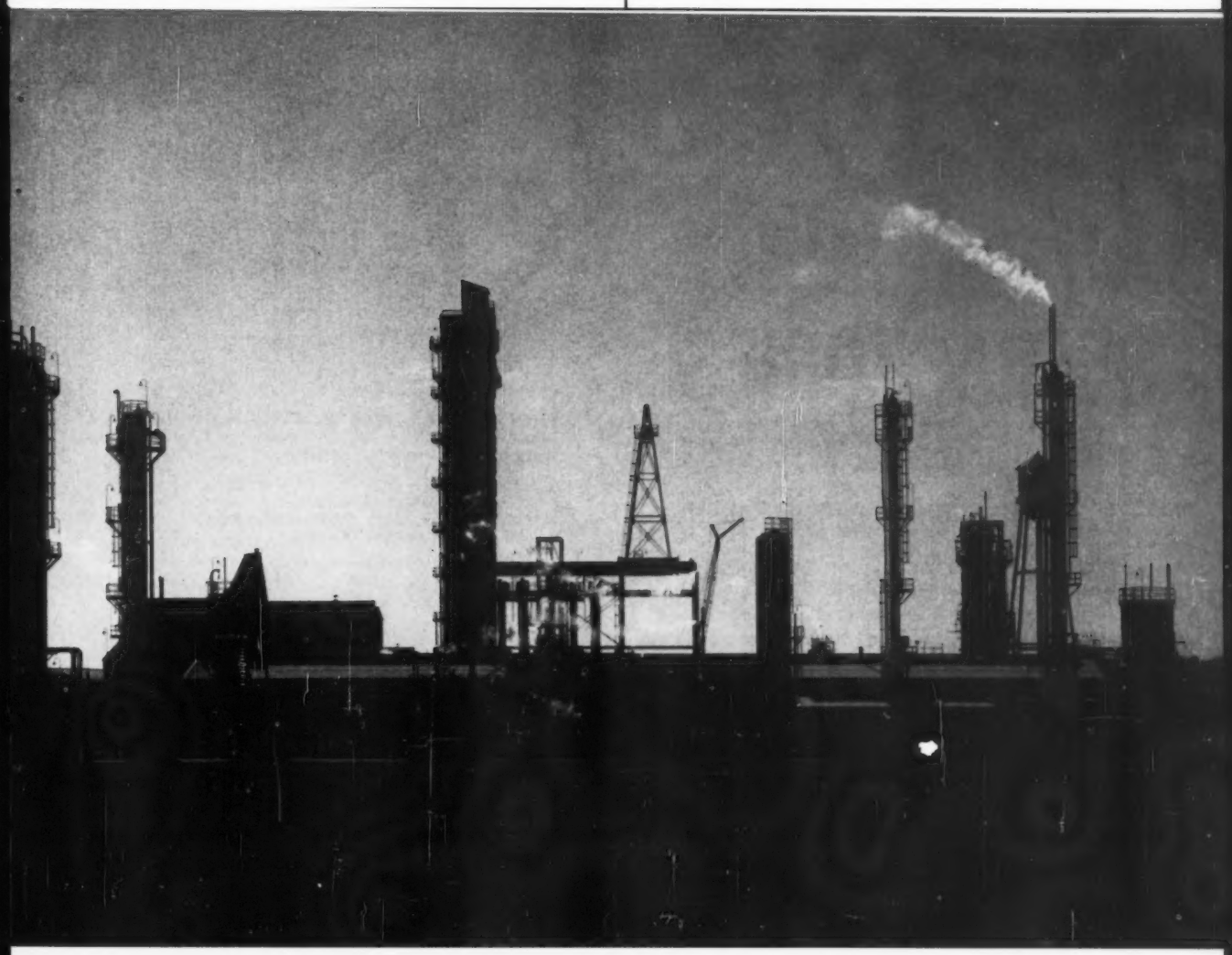
*Write, wire or phone for complete details.*

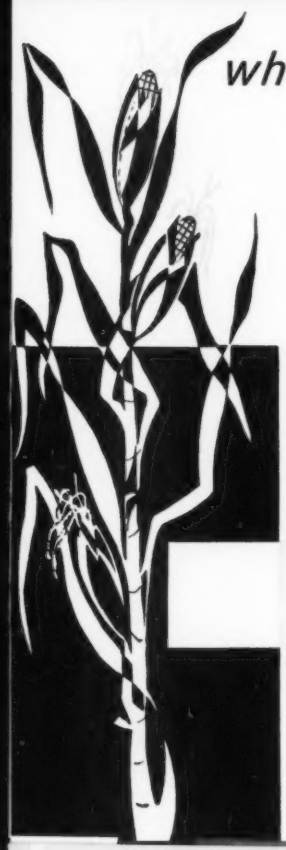
**A. R. WILFLEY and SONS, INC.**

DENVER, COLORADO, U.S.A., P.O. BOX 2330

NEW YORK OFFICE: 122 EAST 42ND ST., N.Y. CITY 17, N.Y

INDIVIDUAL ENGINEERING ON EVERY APPLICATION





## *what do thermal ratings mean to an ear of corn?*

....accurately rated Western heat exchangers, used by Grand River Chemical Company at Pryor, Oklahoma, play a significant role in Grand River's production of urea, using natural gas as the feed. As a commercial fertilizer for crops of all types, urea is increasing rapidly in popularity.

From fertilizer to nuclear power, the petrochemical industry demands unerring accuracy and efficiency from heat transfer equipment. Western is happy to serve these ends.

*A Western representative is ready to discuss your processing problems at your convenience.*

# WESTERN

## HEAT EXCHANGERS

**WESTERN SUPPLY COMPANY**

**P.O. Box 1888 – Tulsa, Oklahoma**

## HARBISON-WALKER

# QUALITY REFRACTORIES

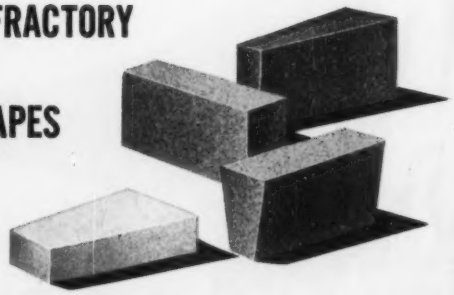
## serve every petroleum processing need

HARBISON-WALKER products comprise the specific types and classes for each particular purpose. Included are the widely diversified monolithic materials, refractory brick of the entire alumina-silica series and high alumina brands of all classes from 50% to 99+% alumina content. From these can be selected the kinds which best fulfill all the special requirements for maximum corrosion resistance to various sulphur compounds and hydrocarbons and to the severe fluxing effect of oil ash in high temperature furnace operations. Harbison-Walker refractories of the various types and classes are especially adapted for withstanding excessive abrasion and erosion and the disintegrating action of reducing atmospheres through critical temperature ranges.

**GUN APPLICATION** — For many installations, Harbison-Walker castables are used to best advantage with various types of air placement guns.

**TROWELLING**—This method is preferred for some applications and the excellent working qualities of Harbison-Walker castables make them easy to use and to secure uniform durable linings.

## H-W REFRACTORY BRICK AND SHAPES



Fireclay Brick—All Classes • High Alumina Brick —All Classes from 50% to 99% alumina • DURO and W-ACID, acid-proof brick, floor tile and • DURO tower packing rings and grid tile • Silica Brick • Basic Brick—All Classes

*Write Technical Service Department regarding the selection of the refractories best suited for your specific applications.*

*World's Most Complete Refractories Service*

# H-W CASTABLE REFRACTORIES and other monoliths

**CASTABLES (all classes) · PLASTIC FIRE BRICK (all classes) SPECIAL GUN MIXES · TROWELLING MIXES**

These monolith-forming refractories are widely used in chemical processing, petroleum refining and petro-chemical industries. They are available in all the many commercial classes which provide the most desirable combinations of physical and chemical properties for each particular requirement. Among these, several which are most widely used with special benefit are briefly described in the following.

**HARCAST** is exceedingly strong and resistant to reducing conditions at operating temperatures and meets rigid specifications used in the chemical processing industries. Its composition and low permeability greatly retards corrosion by gases under high pressures. It is used in severe erosion areas. The approximate service limit is 2800°F.

**H-W 56 LIGHTWEIGHT CASTABLE** combines light weight with high insulating value and strength to the utmost degree. Produced also with a very low ferric oxide content of less than 0.5%, it provides maximum resistance to reaction with various gases. Among important applications are refinery vessel linings, ducts and breechings, boiler back wall and tube decks, air preheater linings, furnace walls, roofs and doors. The approximate service limit is 2100°F.

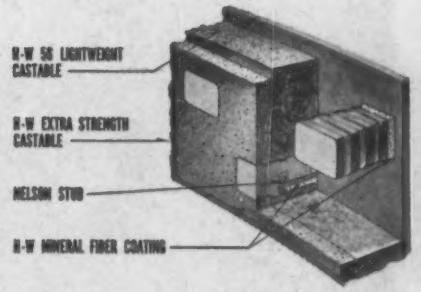
**H-W EXTRA STRENGTH CASTABLE** is exceptionally strong and withstands severe abrasion and erosion at temperatures up to its service limit of 2400°F.

**HARCHROME** is a special chrome castable which is second to none for abrasion resistance for the range of operating temperatures prevailing in feed lines.

**H-W HIGH ALUMINA CASTABLE** is made with high alumina base raw materials and a very pure hydraulic setting binder. Its approximate service limit is 3000°F. A 3200°F. service limit material is also available, made with crystalline alumina base. These castables, due to extreme purity and low permeability, are especially suited for use in highly reducing atmospheres.

### TYPICAL CASTABLE CONSTRUCTION

Illustration shows H-W 56 Lightweight (Insulating) Castable next to the shell with H-W Extra Strength Castable superimposed in hex-steel for working lining.




Typical arrangement of refractory anchor method for monolithic linings. H-W Mineral Fiber Coating provides insulation for metal stud.

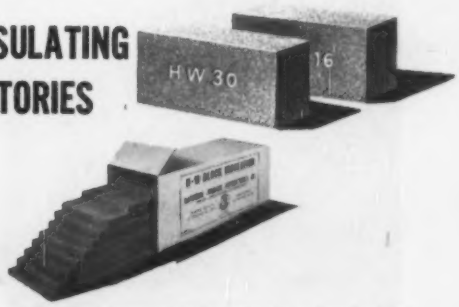
## H-W MORTARS

These include a wide variety of both hot and cold-setting cements which fulfill the requirements for laying all the different kinds of refractory brick. Some leading brands are HARWACO BOND, THERMOLITH and KORUNDAL BONDING MORTAR which provide the requirements for laying the alumina-silica and high alumina refractories ranging up to 99% alumina content.

### HARWACO MASTIC

This plastic cold-setting monolithic refractory has a working consistency similar to that of stiff putty and is ideally suited for plastering with a trowel, as for example, for sealing V-shaped spaces at the exterior face of tangential tubes.

## H-W INSULATING REFRACTORIES




Included are seven classes of insulating fire brick, having service limits of 1600°F. to 3000°F; mortars for laying insulating brick; several brands of castable insulating refractories; H-W BLOCK INSULATION; H-W FINISHING CEMENT; and H-W MINERAL FIBER COATING.

## HARBISON-WALKER REFRACTORIES COMPANY AND SUBSIDIARIES

**General Offices: Pittsburgh 22, Pennsylvania**

**Plants, Warehouses and District Sales Offices in many cities and states**

# All the comforts of home

A little bit of home flies with you when you take a trip on one of today's modern airliners. The friendly comforts . . . the small but important needs . . . are graciously and thoughtfully provided. No wonder so many people are flying.

In 1957, America's airliners carried more than 42,000,000 passengers a total of 25 *billion* miles. Providing the fuels and lubricants to make this possible has been a big job for the petroleum industry. Texaco is proud of its part in this task—for during the last 24 years more scheduled revenue airline miles in the United States have been flown with Texaco Aircraft Engine Oil than with all other brands combined.

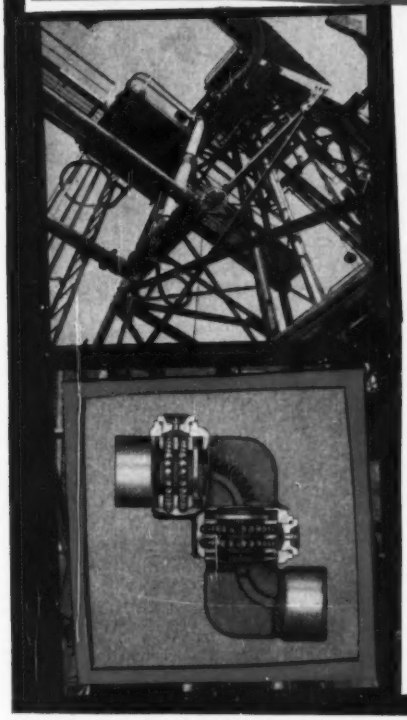
TEXACO

**PROGRESS AT YOUR SERVICE**

THE TEXAS COMPANY

# CHIKSAN HELPS UNION OIL CUT OUT THE COKE

**Swiveling Chiksan Decoking Arms combine flexibility and stamina to handle 1700 psi hydraulic water force used to remove petroleum coke from coke drums**



During refining of crude stock at Union Oil's Oleum refinery, petroleum coke is produced as a valuable by-product. When coke drums become full, they are "decoked" with a high pressure water jet which first drills out a pilot hole, then cuts the coke loose, moving it out of the tower in slurry form. Safety dictates all metal flexible lines. The solution – Chiksan Swivel-Jointed All Steel Decoking Arms. These rugged units provide free turning rotation with all movement carried out in a predetermined arc. Service life of the Chiksan Decoking Arms is measured in years and maintenance involves an occasional packing replacement. If your equipment or plant lines require flexibility, let Chiksan swivel joints provide the answer with less maintenance, limited replacements, and the safety that only steel can provide. Write today for literature and price lists.

**LOOK INSIDE A SWIVEL JOINT.** Detailed attention to detail. Precision machining and specific packing seals for specific services. These are the quality-plus features built into every Chiksan Swivel Joint.

A SUBSIDIARY OF FOOD MACHINERY AND CHEMICAL CORPORATION

fmc CHIKSAN

Please Address Dept. 62

**CHIKSAN COMPANY**–BREA, CALIFORNIA • CHICAGO 5, ILLINOIS • NEWARK 2, NEW JERSEY

Well Equipment Mfg. Corp. (Division), Houston 1, Texas • Subsidiaries: Chiksan Export Company • Chiksan of Canada, Ltd.

#57-29

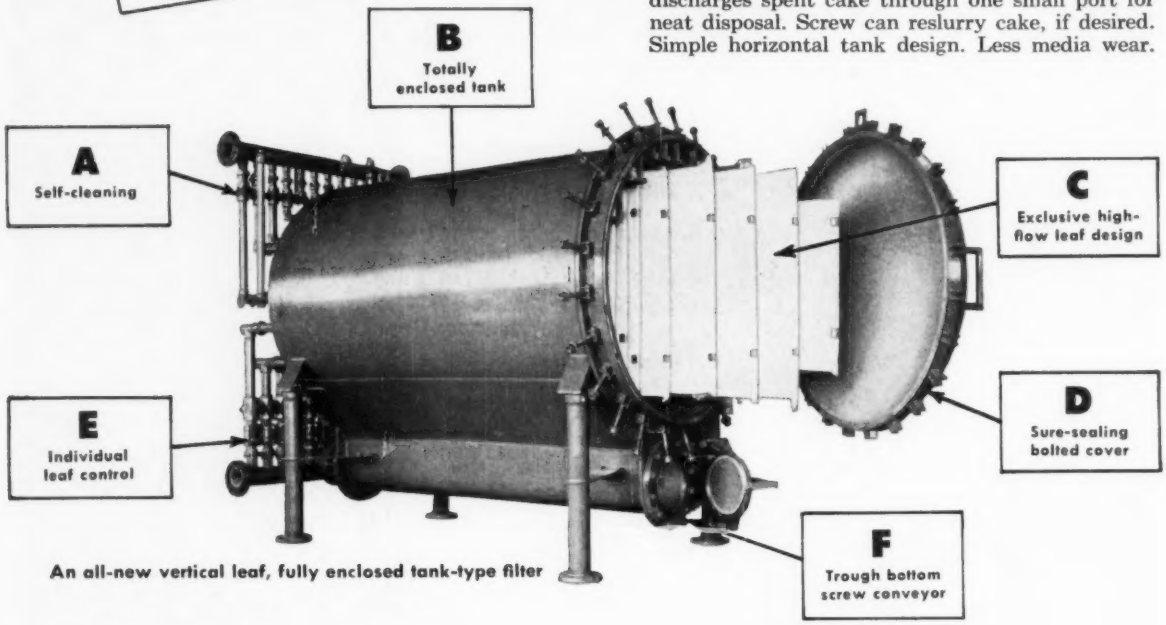
# SPARKLER *Presents* NEW VERTICAL PLATE FILTER . . . MODEL RSC

**EXCLUSIVE OPERATING ADVANTAGES**

***Greater Clarity Control***—Sight glasses, sample cocks and individual control valves for each leaf provide continuous clarity control. Should any leaf not function properly, it may be shut off without interrupting operation.

***Minimum Manpower Required***—A single non-skilled individual is capable of operating a large battery of RSC filters including filter aid addition, cleaning, precoating and supervising.

***Faster Cleaning, Easier Maintenance***—A 560 sq. ft. Model RSC can be cleaned in 10-15 minutes (30-45 minutes total down-time). Leaves are sprayed clean individually. Screw conveyor in trough bottom discharges spent cake through one small port for neat disposal. Screw can reslurry cake, if desired. Simple horizontal tank design. Less media wear.




An all-new vertical leaf, fully enclosed tank-type filter

## *Exclusive Design Features*

**A** Internal sprays sluice filter. Can be independently valved for individual operation under low pressure conditions.

**B** No leaking, dripping or air-borne contamination. Assures a neat filter station with clean, sanitary service. Filter may be insulated to minimize heat loss. Can be installed in low headroom, small floor space areas.

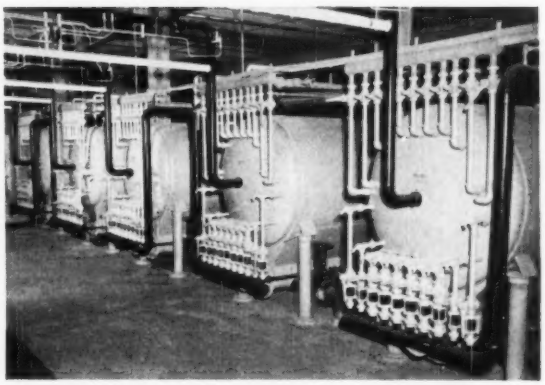
**C** Vertical rectangular leaf design assures maximum flow per filtering area and even precoating. Unexcelled rigidity and durability. Hung on roller carriages for easy individual inspection or removal, no bolts or fastenings. Self-sealing in filter. Stainless steel leaves covered with long-life synthetic cloth or stainless steel wire screens.

**D** Bolted cover on double-hung hinge provides full access to interior without leaf removal. Hydraulic quick-opening cover optional.

**E** Individual plate outlet control valves, sight glasses and sample cocks. Any plate or plates may be shut off without removing filter from service.

**F** Trough bottom with screw conveyor discharges cake neatly and quickly without opening tank. Cake can be reslurried if desired.

**SIZES UP TO 1020 SQ. FT. OF FILTERING AREA**



A battery of five 300 sq. ft. Model RSC filters in operation

**SPARKLER**

**MANUFACTURING CO., Mundelein, Illinois, U.S.A.**

Sparkler International Ltd., Leliegracht 9, Amsterdam-C, Holland
Manufacturing plants in Canada, Holland, Italy and Australia

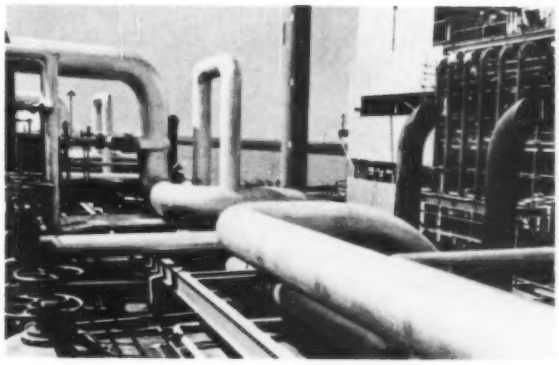
*Filtration engineering and manufacturing exclusively for over 30 years*



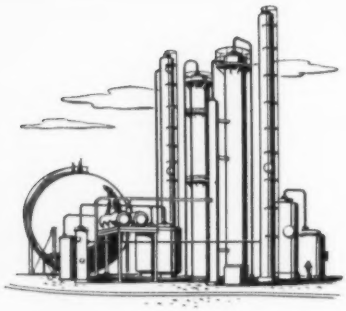
For more data on advertised products, use Readers' Service Cards, last page.

# B&W

## STEEL TUBULAR PRODUCTS,
### WELDING FITTINGS AND FLANGES
## For the Petroleum and Petrochemical Industries



THE BABCOCK & WILCOX COMPANY · *TUBULAR PRODUCTS DIVISION*



**In the Oil Industry**

# Matching Tubes to Jobs is a B&W Specialty

Tubular products play such an important part in refineries, petrochemical plants, and in oil field operations that selecting the right tubing for any specific job is a vital consideration for economical performance. That's why B&W specializes in matching tubes to jobs.

Many advances in the petroleum industry have placed a new emphasis on tubing requirements to meet operating conditions, which include new combinations of high pressures and temperatures, sub-zero temperatures, corrosion, oxidation, abrasion, stress, and ease of fabrication.

Through the development of new alloys, special tube sizes and treatments to develop special properties, B&W has helped to solve many of the problems relating to the use of tubular products by the petroleum industry. And because B&W produces both seamless and welded tubing, seamless pipe, and seamless welding fittings in a complete range of carbon, alloy, and stainless steels, you can depend on B&W to offer unbiased assistance in matching tubes to jobs.

Let B&W help you in the selection of tubular products for any type of oil industry service from oil well pipe and drilling equipment to heat exchangers, oil heating furnaces, piping, or other tubing applications.

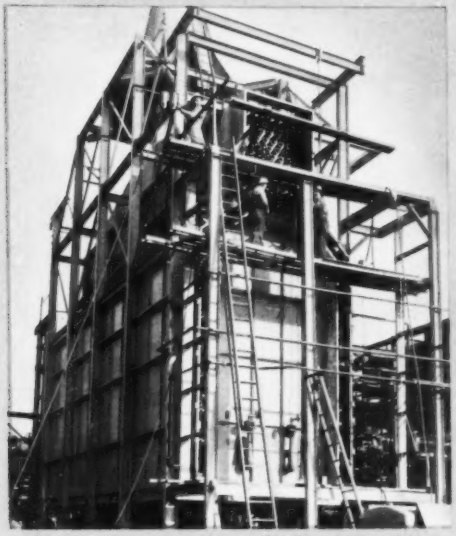
***For complete details, write for Bulletin TB-417.***

**THE BABCOCK & WILCOX COMPANY**

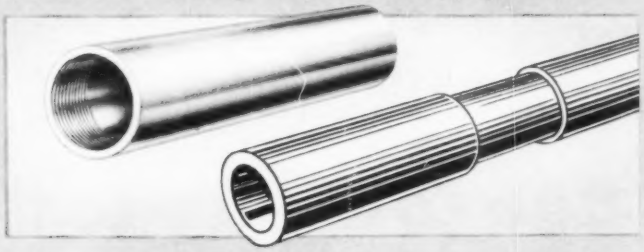
***TUBULAR PRODUCTS DIVISION***

Seamless Tubing • Welded Tubing
Pressure Tubing
Alloy Pipe • Mechanical Tubing
Seamless Welding Fittings
Forged Steel Flanges,
in Stainless
Alloy and Carbon Steels

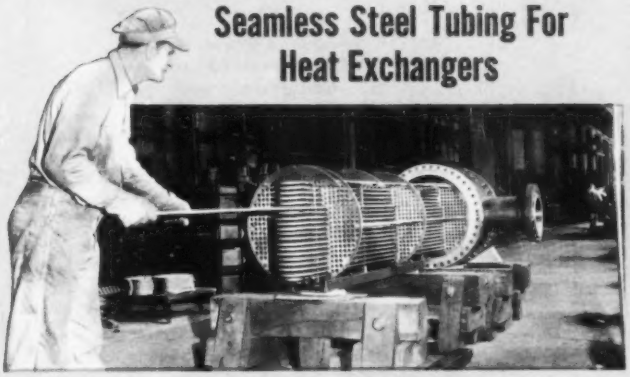
## Seamless Steel Tubing For All Types of Heaters



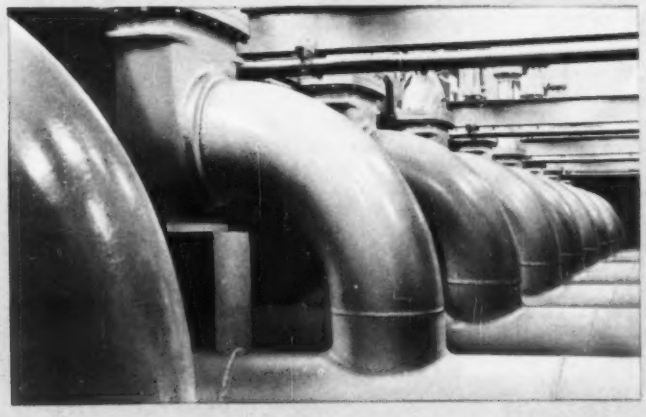
## Mechanical Tubing For Oil Field Equipment



## Seamless Steel Tubing For Heat Exchangers

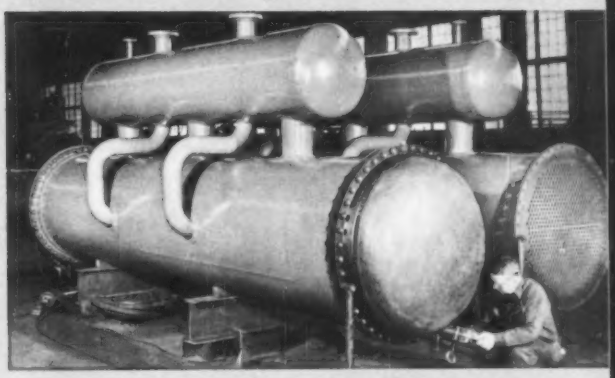


## Seamless Welding Fittings For Pipelines

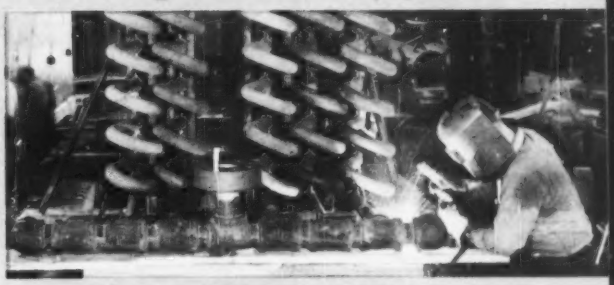


## Seamless Alloy Steel Pipe & Welding Fittings For Process Piping

## Welded Steel Tubing For Heat Exchangers



## Steel Tubing For Process Equipment



## Alloy Steel Oil Well Tubing

*In the Oil Industry*

# B&W Is the One-Source Supply For Specialty Tubing and Welding Fittings

Its association with the petroleum industry, through the past years of significant technological development, has given B&W an understanding of the industry's needs now—and in the future.

B&W's experience has resulted in products which meet the special needs of drilling, production, and refining operations. It's why B&W is able to offer a complete *one-source* service. A service which now offers an unusually large selection of tubular products from which to choose. There is a complete range of tubing sizes, grades, finishes, and analyses. In stainless, carbon, and alloy steels. In seamless or welded tubing.

B&W pledges to continue its long record of creative metallurgy and precision manufacture of seamless and welded tubular products, with the development of new techniques and new analyses to keep abreast of industry's demand for new materials to meet new conditions. Already, in laboratories and in pilot plants, B&W is helping write tomorrow's history today.

## SALES OFFICES

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BOSTON (Wellesley 81), MASS. . . . . 66 Central Street
CHICAGO 3, ILL. . . . . Room 800, 105 S. LaSalle Street
CINCINNATI 6, OHIO . . . . . 2330 Victory Parkway
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PHILADELPHIA 2, PA. . . . . 2222 Packard Building
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SYRACUSE 3, N. Y. . . . . 731 James Street
TULSA 3, OKLAHOMA . . . . . 427 S. Boston Street

Warehouse stocks of B&W Seamless and Welded Tubing and Seamless Welding Fittings are maintained by distributors in principal cities

## FOREIGN SALES REPRESENTATIVES

CANADA—John H. Bolton—159 Bay Street, Toronto
CUBA—Agencia Macfarlane, S. A., Apartado No. 109, Havana
MEXICO—C. Norman Frees—Balderas 31-602, Mexico 1, D. F.
PUERTO RICO—Portilla Corp.—P. O. Box 4349—San Juan 22

TA-8086-A

**THE BABCOCK & WILCOX COMPANY**
**TUBULAR PRODUCTS DIVISION**

*General Offices:* BEAVER FALLS, PENNSYLVANIA

*Plants:* BEAVER FALLS, PA.—ALLIANCE, OHIO—MILWAUKEE, WIS.

# HERE'S HOW YOU CAN SAVE MONEY ON PRESSURE SWITCHES FOR YOUR SPECIAL REQUIREMENTS...

For sensing pressure differences of .45 to 80 inches of water vacuum or pressure.
For extreme accuracy, single and dual setting switches in the working range of 30 inches of mercury vacuum to 100 P.S.I. pressure. Housed models.
For mounting in a common control cabinet, stripped models in the working range of 30 inches of mercury vacuum to 100 P.S.I. pressure.
For differential sensing of .05 to 100 P.S.I.
For dual setting high and low limit protection.
For widely adjustable differential and high proof pressure.
Explosion-proof models for low pressure and vacuum sensing, single and dual setting.
Models with variable actuation value.
For heavy duty, single and dual setting up to 7000 P.S.I. proof pressures.
Models with external calibration dial.
Explosion-proof models for high pressures.
For use with highly corrosive media.
For accurate sensing of high pressures, single and dual setting.
For extremely long service life, high proof at settings from 35 to 12,000 P.S.I.
For sensing high differential pressures.

If you feel that the pressure switch for your application has to be tailor-made to your requirements, we can offer you the know-how, the experience and probably considerable savings in the bargain.

**The know-how** is available to you in the form of an engineering and production facility entirely specialized on the design and manufacture of pressure switches. Ask to see the 20-minute sound movie, "The Meletron Story."

**The experience** we can offer you has been put to the test in every conceivable type of industrial pressure switch application. Ask our representative in your area to show you applications resembling your own.

**The savings** you can make will be apparent when you consider that there are over six hundred pressure switches listed in our catalog. Even if you should require a special pressure switch, the major components are already in production. Ask for the latest pressure switch handbook and catalog.

PRESSURE SWITCH DIVISION

## Barksdale valves

5125 ALCOA AVENUE • LOS ANGELES 58 • CALIF

THERE IS A BARKSDALE REPRESENTATIVE IN YOUR AREA:

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| Arizona, Phoenix | St. Louis |
| California, Los Angeles | Nebraska, Omaha |
| San Diego | New Jersey, Neptune |
| San Francisco | New York, Buffalo |
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| Connecticut, Wethersfield | Rochester |
| Dist. of Columbia, Washington | Syracuse |
| Florida, Miami | North Carolina, Charlotte |
| Georgia, Atlanta | Ohio, Cincinnati |
| Illinois, Chicago | Cleveland |
| Rockford | Dayton |
| Indiana, Indianapolis | Oklahoma, Tulsa |
| Kansas, Wichita | Oregon, Portland |
| Kentucky, Louisville | Pennsylvania, Abington |
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For more data on advertised products, use Readers' Service Cards, last page.

# For your next project... avail yourself of

# PRACTICAL EXPERIENCE

The industry is [illegible] process engineering problems [illegible]. The engineering staff of Stearns-Roger has these resources because of the many areas in which Stearns-Roger is continually engaged: metallurgy, power, atomic energy, chemical processing, and oil and gas processing. These men are ever alert to new designs for more efficient plant arrangement or operation.

Stearns-Roger has for years been closely identified with the oil and gas industry. Processing plants designed and built by Stearns-Roger operate from the extreme cold of Canada to the mild conditions of the Texas Gulf, ranging from the very large to the very small.

Starting with analysis of well-head gas, S-R facilities are complete for handling each successive step through process design, general engineering, fabrication of special equipment in our shops, and field installation with our own personnel. We deliver a completed plant, operating, to meet the customer's long term needs.

**Stearns-Roger**

THE STEARNS-ROGER MFG. CO. • DENVER, COLORADO

DENVER • HOUSTON • EL PASO • SALT LAKE CITY

Stearns-Roger Engineering Company, [illegible]
Calgary, Alberta

# harnessing HF pays off

***. . . Pennsalt experience helps you do it***

**Hydrofluoric acid alkylation** gives you lower catalyst cost per barrel of alkylate . . . shortens reaction time and catalyst settling time . . . reduces cooling equipment expense . . . eliminates spent acid problems and large acid inventories. You can cash in on these economies because . . .

**HF can be handled safely** . . . as safely as many other active chemicals you're already using.

**Expert technical aid from Pennsalt** shows you how to handle and store HF . . . advises you on piping, valves and other equipment and materials . . . helps you with employee training programs. We offer you this service because . . .

**Pennsalt specializes in HF.** We've pioneered in developing ways to make, ship and store it better, safer and more economically. Pennsalt® HF meets or surpasses alkylation process purity requirements. Ample supplies are available, in cylinders and tank cars of convenient sizes. Call or write for more information or ordering.

*See our catalog in CMC*

INDUSTRIAL CHEMICALS DIVISION

**PENNSALT CHEMICALS CORPORATION**

3 Penn Center, Philadelphia 2, Pa.

Chicago • Detroit • New York • Philadelphia • Pittsburgh • St. Louis • Appleton • Atlanta
Airco Company International, New York • Pennsalt Chemicals of Canada Ltd., Oakville, Ontario

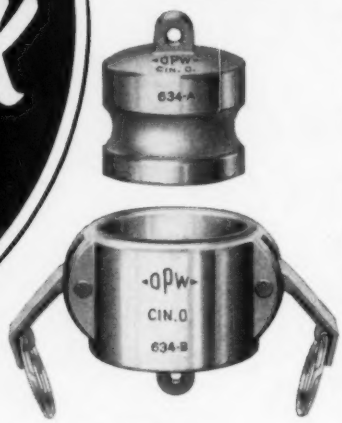
Pennsalt Chemicals
ESTABLISHED 1850

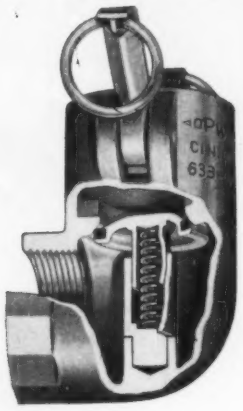
In the West, Pennsalt inorganic chemicals are available through Pennsalt of Washington Division, with plants at Tacoma, Washington and Portland, Oregon.

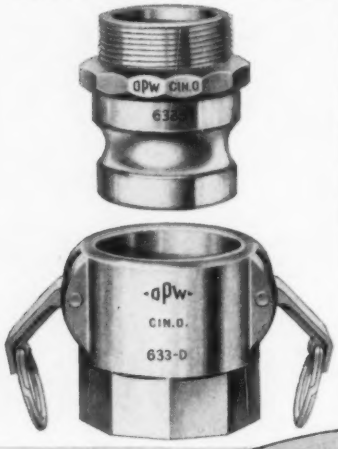


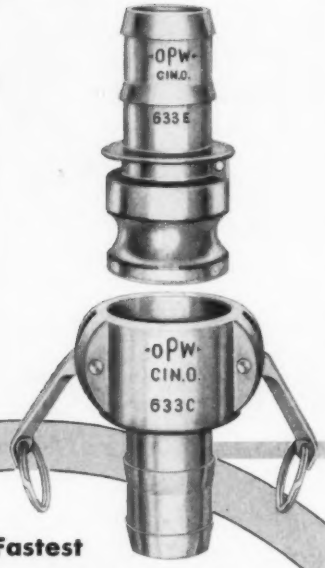
For more data on advertised products, use Readers' Service Cards, last page.

# OPW KAMLOK COUPLING ASSEMBLIES





**The Fastest**

**Safest, Surest Coupling Known!**

OPW KAMLOKS add extra life to hose . . . guarantee greater security in handling all types of liquids. A perfectly, tight, no-leak seal is made instantly without twisting, kinking or straining of hose. Merely slip Adaptor into Coupler and press cam levers down. No threads to engage, no twisting friction against gaskets, no tools required for a connection that holds fast, stays tight.

OPW KAMLOKS are available in any combination to meet coupling requirements in sizes from ½" to 6" inclusive.

**ALL OPW KAMLOKS ARE 100% GAUGED FOR COMPLETE INTERCHANGEABILITY.** All styles of Adaptors fit in all styles of Couplers of the same size.

**BRONZE • MONEL • ALUMINUM • STAINLESS STEEL • SEMI STEEL**

**Free Catalog F-10R provides detailed recommendation and sizing, charts — factual information to help in planning, selecting and determining installation.**

**OPW CORPORATION**

2735 Colerain Ave., Cincinnati 25, Ohio, KIrby 1-5400

# let's lay it on the line

THE total cost of all valves used by industries where operations involve fluid control represents a huge investment. It is unfortunate that many of these valves are not selected, as they should be, on a basis of proved performance. Today, with labor and material costs at an all-time high, the cost of valve maintenance should be watched as carefully as the operating expense of larger plant units. Excessive maintenance of one inferior valve is unimportant, but, multiplied by thousands, it can be a serious drain on operating budgets.

Why take chances with inferior or worn out valves? You can keep maintenance costs at a minimum by replacing them with SMITH Forged Steel Valves — the valves that engineers and maintenance men swear *by* — not *at*.

Start the New Year right! — send for our catalog today.

150 lb. - 300 lb. - 600 lb. series to A.S.A. face-to-face dimensions

**SMITH FORGED STEEL FLANGED END VALVES**

Especially designed to meet the exacting requirements of the Refinery, Chemical, Petrochemical and Process Industries, SMITH Flanged End Valves give you longer, trouble-free life in service. Special features and precision construction combine to give them the extra stamina to resist the demands of ever-increasing temperatures, pressures and corrosion.

Smith FORGED STEEL Valves

**NEW ENGLAND VALVE Corporation**

**BOX 1047**
**WORCESTER, MASSACHUSETTS**

New England Valve Corp. of Canada Ltd.
Factory & Offices: 1 Seneca Avenue • Port Credit, Ontario



For more data on advertised products, use Readers' Service Cards, last page.

No matter the size of the job, critical piping is work only for specialists. So many top power and processing plants know the lasting satisfaction to be had from using Mitchell direct from start to finish...for prefabricating and erecting your new high-temperature, high-pressure piping...ask us in.

**W. K. MITCHELL & CO., INC.**

**Philadelphia 46, Pa.**

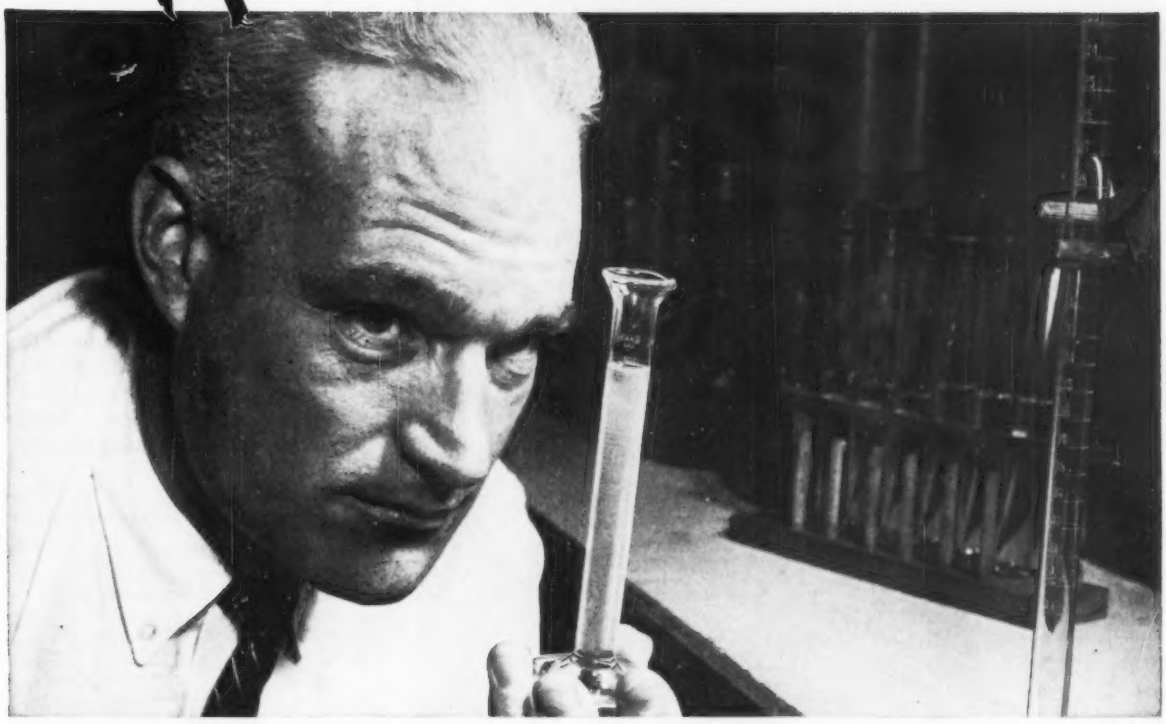
*WESTPORT JOINT*
(PATENTED)

# MITCHELL PIPING
SINCE 1899

**PIPING FABRICATORS AND CONTRACTORS**

**BRIDGEPORT "T" MEN* IN ACTION**

**Technical Service Men*



# The Case of the Acid Assailant

*Where's the Culprit?* Field spot tests of water samples give revealing clues as to cause of corrosion.

*Case Solved.* Initial recommendations go out to customers immediately and are followed by a detailed written report.

It was an ordinary afternoon in the Corrosion Lab when a sample of raw cooling water and a corroded condenser tube arrived from a midwest chemical company. Accompanying the evidence was a letter of explanation and a completed Technical Service corrosion questionnaire. The customer wanted help. Bridgeport "T" men swung into action.

The water sample was analyzed. It checked out against the original sample taken when Bridgeport tubes were first installed. Still no conclusive evidence of corrosive media was found in the water. Yet, examination of the tubes revealed them to be corroded both by acid and an abrasive.

The Bridgeport "T" Man visited the plant site and retraced the case step by step.

The first break came when a spot check was made of water taken directly from the cooling tower. A significant acid content was noted. Further on-the-spot examination showed that gas and fly ash from the plant smokestack were carried by prevailing winds over the cooling tower and deposited in large amounts in the tower. Closer examination of the cooling tower uncovered acid-forming sludge and abrasive fly ash in suspension.

The Bridgeport "T" Man, in an extensive report of his findings, recommended corrective measures. Company adopted recommendations. Tubes saved. Case closed.

This is a typical case from the files of Bridgeport Technical Service, a group set up to help Bridgeport customers get maximum life and service from their power and process equipment.

For the best service and advice on condenser or heat exchanger tubes call your nearest Bridgeport Sales Office today.

DEPT. B301

## BRIDGEPORT CONDENSER TUBES

Bridgeport Brass Company, Bridgeport 2, Connecticut

Sales Offices in Principal Cities • In Canada: Noranda Copper and Brass Limited, Montreal

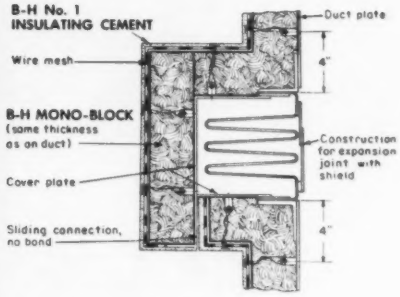


For more data on advertised products, use Readers' Service Cards, last page.

## One Block Insulation that gives you Easier Handling, Faster Application...

# BALDWIN-HILL MONO-BLOCK®

Ducts and housings on two 560,000 lb. per hr. boilers, operated by a large Taconite producer in Minnesota, were insulated with B-H Mono-Block (effective to 1700° F) by simple, standardized methods which permitted minimum application cost. The light weight of Mono-Block as well as its ease of cutting holes for tie wires and shaping to conform to surface irregularities facilitated the special insulating treatment of duct flanges and stiffeners. For a finish coat, B-H No. 1 Insulating Cement was used.




### Duct Expansion Joint

An interesting application of Mono-Block is on the expansion joints where movement will exceed 3". Block was applied to two independent sections capable of sliding with respect to each other.

# BALDWIN-HILL Company

CONTRACT APPLICATION SERVICE AVAILABLE

701 Breunig Ave., Trenton 2, N. J.

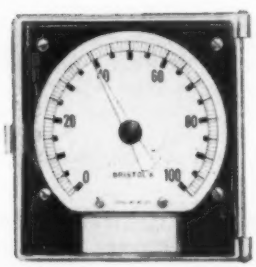
Kalamazoo, Mich. . . . Huntington, Ind. . . . Temple, Tex.

For more information on B-H Mono-Block, B-H No. 1 Insulating Cement and other B-H Insulations, write for catalog or see it in Sweet's Plant Engineering File.

# Motor drive gives these miniatures high torque, unusual accuracy

No galvanometer type drive here!

Bristol Series 663 Miniature Electronic Dynamaster* Recorders and Indicators employ a two-phase, motor-driven, slide wire self balancing principle. Here's plenty of torque for operating alarm contacts, electric control contacts, or retransmitting slidewires. Dead band is only 0.15%. Here, too, is twice the accuracy . . . ½% of scale . . . you get in ordinary miniatures.



**SAME INSTRUMENT** also made as an indicator, interchangeable with recorder of similar characteristics in 10 seconds. Actual size: 5" x 5½".

***Full plug-in flexibility, too.*** You can interchange chassis of the 663 in 10 seconds . . . replace it with either recorder or indicator instruments . . . both plug in easily without tools. Chassis also pulls out to intermediate position for chart changing and inking without disconnecting from circuit. Easy range change, too.

These features simplify planning of graphic control panels. They permit centralized recording and/or indicating of a large number of variables in minimum space. 15 miniatures mount in less space than two full sized units. Human engineering makes 3" charts and dials easy and accurate to read.

Remember, too, only Bristol offers full lines of both full size and miniature instruments. You can count on unbiased recommendations and dependable instrumentation from Bristol. The Bristol Company, 111 Bristol Road, Waterbury 20, Connecticut. 8.12

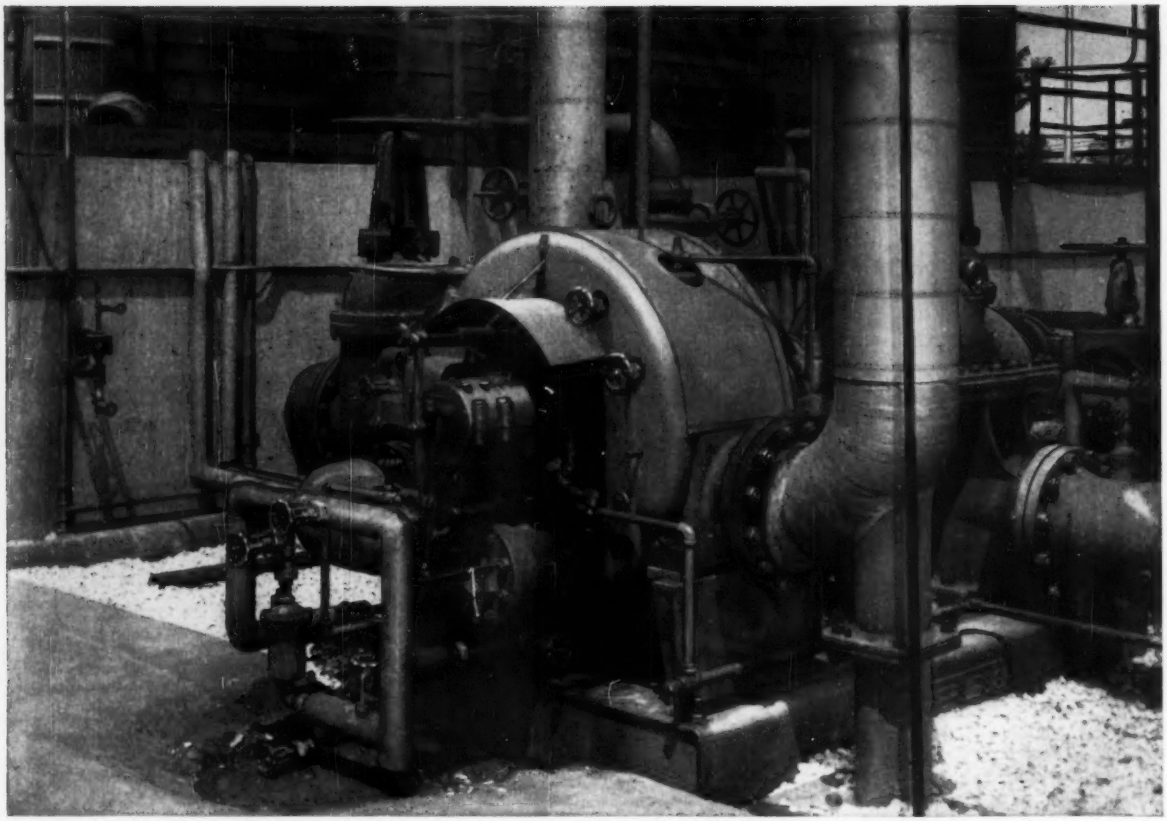
*T. M. Reg. U.S. Pat. Off.

**BRISTOL** TRAIL-BLAZERS IN PROCESS AUTOMATION

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

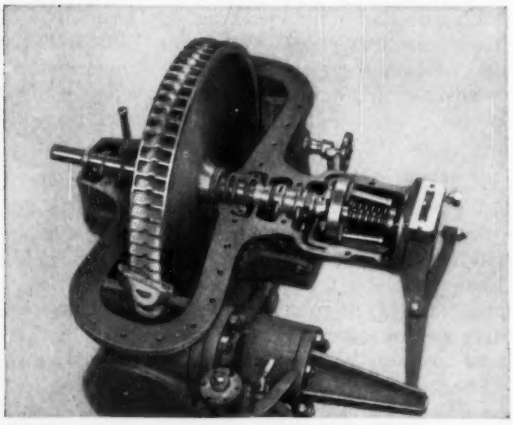


For more data on advertised products, use Readers' Service Cards, last page.



# TERRY SOLID-WHEEL TURBINES

*used exclusively at Baton Rouge plant of W.R.Grace & Co.*



The upper photograph shows one of the 17 Terry turbines installed at the Baton Rouge, La., GREX high-density polyethylene plant of W. R. Grace & Co. Above, a typical Terry solid-wheel turbine with cover removed to show the wheel construction.

In purchasing equipment for their new 50,000,000-pound high-density polyethylene plant, W. R. Grace & Co. standardized, wherever possible, on a single source of supply for each type of equipment used. Consistent with this policy, Terry steam turbines were used exclusively throughout the utility and process sections of the plant.

A total of 17 turbines were placed in service for driving pumps and fans. These are all of the solid-wheel type, ranging in capacity from 50 to 240 HP.

Terry solid-wheel turbines are known for their long life and sure dependability under the most-trying operating conditions. They feature a single-piece wheel which is virtually indestructible.

Send for details of these trouble-free turbines. Ask for a copy of bulletin S-116.

**THE TERRY STEAM TURBINE COMPANY**
**TERRY SQUARE, HARTFORD 1, CONN.**

TERRY

TT-1214

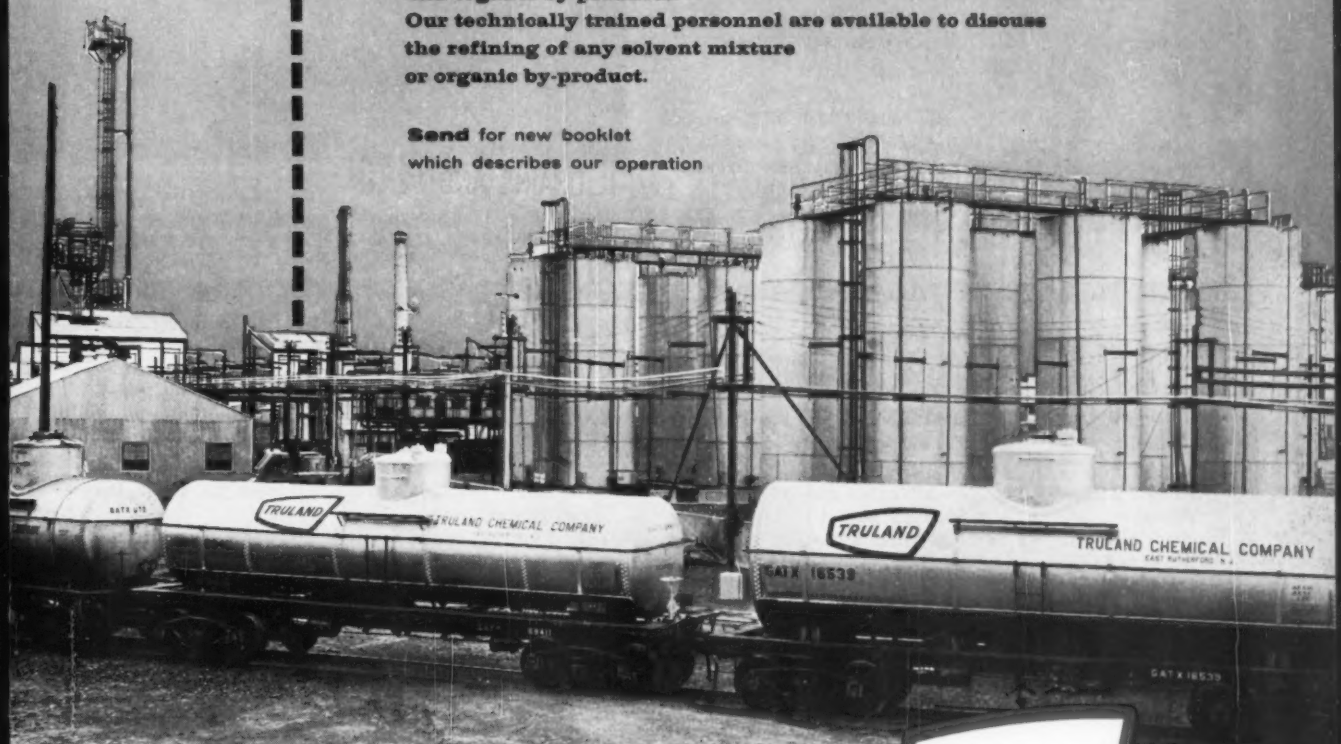
# REFINING OF YOUR BY-PRODUCTS

## Partial List of Products Processed

Acetone
Amyl Acetate
Amyl Alcohol
Benzene
n-Butyl Acetate
n-Butyl Alcohol
Butyl Cresols
Butylene Glycol
Capryl Alcohol
Carbon Tetrachloride
Chlorbenzene
Chloroform
Dibutyl Phenol
Dibutyl Phthalate
Dicapryl Phthalate
o-Dichlorbenzene
Diethanolamine
Diethylene Glycol
Dimethyl Phthalate
Dimethyl Sebacate
Dipropylene Glycol
Dodecyl Alcohol
Dodecylbenzene
Ethyl Acetate
Ethylene Dichloride
Ethylene Glycol
Ethyl Hexanediol
Ethyl Lactate
Glycerine
Glycol Ethers
Hexyl Alcohol
Iso-butyl Alcohol
Isodecyl Alcohol
Iso-octyl Alcohol
Isophorone
Isopropyl Acetate
Isopropyl Alcohol
Methyl Alcohol
Methyl Amyl Alcohol
Methylene Chloride
Methyl Ethyl Ketone
Methyl Hexyl Ketone
Methyl Isobutyl Ketone
Monoethanolamine
Naphthas
Nitrotoluols
Nonyl Phenol
Octyl Acetate
Perchlorethylene
n-Propyl Alcohol
Propylene Glycol
Pyridine
Toluene
Trichlorbenzene
Trichlorethylene
Tricresyl Phosphate
Triethyl Amine
Triethylene Glycol
Trimethyl Borate
Vinyl Acetate
Xylene

**The facilities and experience of Truland may be employed advantageously for the economical upgrading and disposal of solvent mixtures and organic by-products. Our technically trained personnel are available to discuss the refining of any solvent mixture or organic by-product.**

**Send** for new booklet which describes our operation




TRULAND CHEMICAL COMPANY
EAST RUTHERFORD, NEW JERSEY

TRULAND

A DIVISION OF THE TRUBEK LABORATORIES

# Here's a steam trap

## ..and for seven sound reasons:

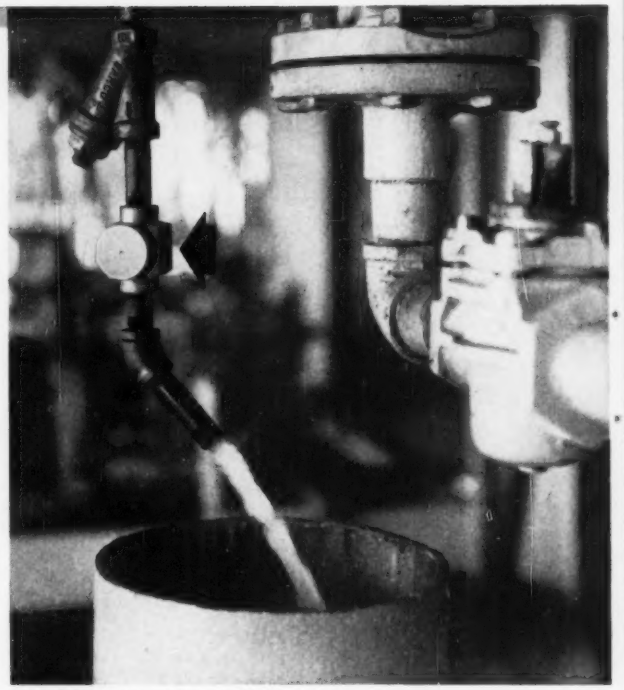
1. *Simplicity* – only one moving part.

2. *Maintenance* – practically zero. 3. *One trap* for all pressures from 10 to 600 psi.

4. *Uniform performance* – operates equally well on heavy, light, or no condensate load.

5. Operates against *back pressures* up to 50% of inlet pressure. 6. *Rugged* – unaffected by superheat, water hammer, vibration, or corrosive condensate. 7. *Minimizes inventory* of spare parts.

**Sarco TD's on outdoor blending tanks of Shell Oil Company, Sewaren, New Jersey, are installed vertically, instead of in the usual horizontal position, in order to drain coils after shut-down, thus preventing freezing.**



### 1. DRAINS AND VENTS

at start-up. Immediately rids lines of condensate and air to permit normal operation. This eliminates the need for manual opening of valves to drain the system.

### CONTROL COSTS

In these days of sharp emphasis on cost control, Sarco Thermo-Dynamic TD Traps are helping plants to deliver the full productive power of every pound of steam. And because the TD has no mechanism . . . no gaskets . . . no narrow channels to clog, maintenance cost on the TD is almost nil. As one plant engineer puts it: "This TD is a cinch to install, it's no bigger than a tee fitting, and it works in any position. The TD is the one steam trap we can install and forget."

### CHOOSE THE RIGHT TRAP

There's an infinite variety of applications, temperatures, pressures and loads in industrial steam piping. Sarco can help you select the right trap for every job of air and condensate removal, saving you money and down-time.

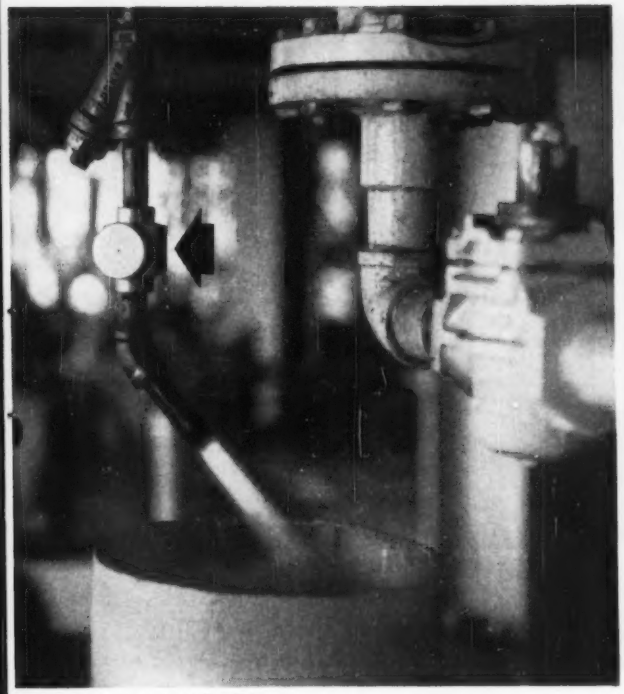
### HOW ABOUT THE BUCKET TRAP?

With the development of the patented* Sarco Thermo-Dynamic Steam Trap, the bucket trap suddenly aged 50 years. In a nostalgic way we feel somewhat sorry, because *our* Sarco bucket trap has made us thousands of friends. But frankly, it's no match for the new Sarco TD. Progress is progress.

Some of our customers who are getting satisfactory service from our bucket traps may prefer to replace their old Sarco bucket traps with *new* Sarco bucket traps. If you feel this way, we're flattered enough to keep on making Sarco Bucket Traps – strong, sturdy and durable as ever. Let us suggest, however, that you at least give the new Sarco Thermo-Dynamic Steam Trap a try, under your most exacting conditions.

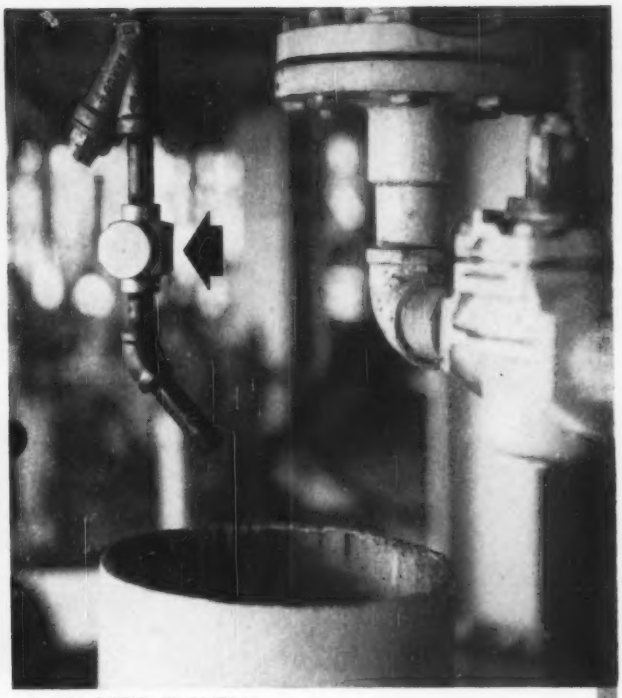
*U.S. Pat. No. 2,817,353 T. M. Reg. U. S. Pat. Off.

# that does what a steam trap should



2. DISCHARGES

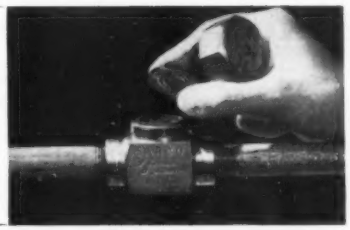
air and condensate at steam temperature as rapidly as they collect. Does not wait for a bucket of steam to leak through a small orifice.



3. CLOSES TIGHTLY

There is no continuous bleed; nor is there loss of buckets of steam as in the bucket trap which must discharge steam with each cycle.

## MAINTENANCE TIME: 40 SECONDS!



How long does it take your maintenance crew to service an ordinary trap? If it's over a couple of minutes, you're throwing away valuable time. The Sarco TD can be cleaned, blown out, if necessary, and reassembled on the line, in as little as 40 seconds. 6345-B

*Sarco can give you impartial advice on trap selection because Sarco makes All–5 Types:*
*Thermo-Dynamic . . . Thermostatic . . . Liquid Expansion . . . Float Thermostatic . . . Camlift Bucket*

**SARCO COMPANY, INC.** 635 Madison Avenue, New York 22, N. Y.

STEAM TRAPS • TEMPERATURE CONTROLLERS • STRAINERS • HEATING SPECIALTIES

**TRECO DESIGNS, ENGINEERS AND CONSTRUCTS PETROCHEMICAL PLANTS FOR THE PRODUCTION OF EVERYTHING FROM A TO X, OR ACETALDEHYDE TO XYLENE**

We haven't been around for Petroleum's entire first century, but we *have* helped it through the seventeen years of its greatest growth. We are proud of our ever-expanding role in the greatest industry on earth, and we are proud, too, of these reasons behind this expansion: greater efficiency, careful attention to each detail of engineering and construction, and a policy of always giving you, our customer, greater value than the contract calls for, whether you are in the petroleum refining industry or the fields of chemicals and petrochemicals.

Because of the many repeat contracts from satisfied customers and the confidence placed in us by many new customers, we have grown into an organization capable of handling your every engineering and construction need. We have proved this to nearly every refiner, big or little, in the industry—and we expect to go on proving it through Petroleum's next hundred years.

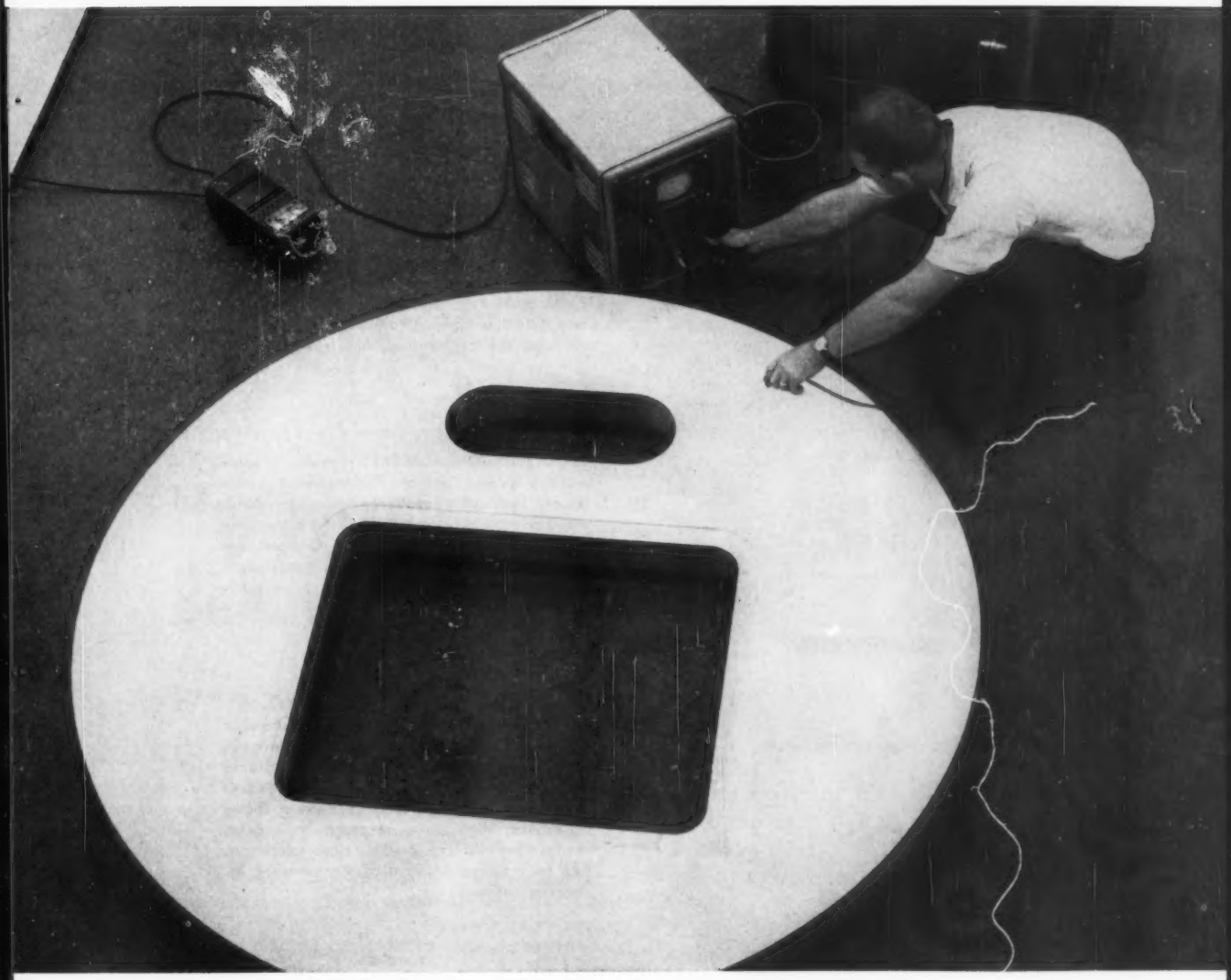
....talk with the TRECO man.....

TRECO

A DIVISION of VITRO CORPORATION of AMERICA

**The REFINERY ENGINEERING Company**

FARMINGTON NEW YORK TULSA TORONTO



# "test soundings"

## . . . prove the soundness of Carlson stainless steel plate

"HEAVING THE LEAD" may be the traditional way to keep a boat off the shoals, but modern sound wave instruments do it faster and better. And, for a very different reason, modern sound wave devices are used to assure quality stainless steels. Carlson was one of the first producers to use ultra-sonic equipment for testing heavy gauge stainless plate.

In ultra-sonic testing, sound waves take a penetrating look inside and positively determine structural quality. A complete report on the results of the test is supplied to the customer. By specifying ultra-sonic tested plate, builders of aircraft components and nuclear equipment can tell in advance that the material will meet their rigid requirements.

Ultra-sonic is only one of the many tests used to maintain the high quality of Carlson stainless plate. The final, and most important test, is when *you* get repeat orders from *your* customers.

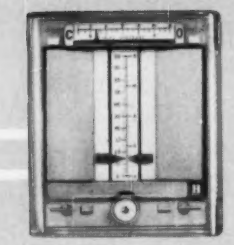
Write, wire or phone for complete information on all Carlson services.

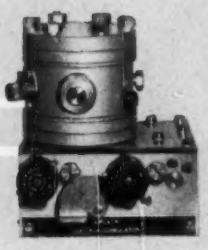
**G. O. CARLSON Inc.**

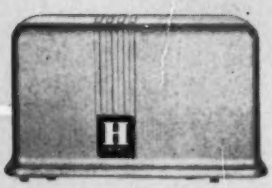
*Stainless Steels Exclusively*

**136 Marshalton Road**
**THORNDALE, PENNSYLVANIA**
***District Sales Offices in Principal Cities***

**PLATES • PLATE PRODUCTS • HEADS • RINGS • CIRCLES • FLANGES • FORGINGS • BARS AND SHEETS (No. 1 Finish)**







***TEL-O-SET* RECEIVERS** can be used with any pneumatic force-balance controller. Recorder and indicator chassis are interchangeable: to make a change, or overhaul the instrument without process downtime, just pull out one chassis and slide in another. All adjustments and normal servicing can be handled from front of panel.

***TEL-O-SET* CONTROLLERS** provide proportional-plus-reset control. Quick-connect switch permits removal of controller while process remains on manual control from front of panel. One basic model controls any variable. Unitized construction of all components simplifies maintenance, makes reassembly foolproof. Rate action easily added.

***TEL-O-SET* TRANSMITTERS** are as accurate at small spans of 20 psi and 50°F as at wide spans of 150 psi and 400°F. Range is fully adjustable without adding or changing parts; no need to stock an assortment of thermal systems or spring assemblies. High-speed response to process changes permits control within close tolerances. Can be mounted at point of measurement, indoors or outdoors.

# You save in <u>many</u> ways with TEL-O-SET transmitters, receivers, controllers

***. . . today's most advanced miniature pneumatic instruments***

Designed to work together as a team, *Tel-O-Set* transmitters, receivers, and controllers also can be used to advantage with other miniature and conventional size instruments. They're easily installed and serviced.

Get complete details on *Tel-O-Set* instruments from your nearby Honeywell field engineer. Call him today . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa.

# Honeywell

First in Control

# NEW!

## Honeywell Bellows Meter...

*unequalled for accuracy, stability, versatility in flow and liquid level metering*

The new Honeywell Bellows Flow Meter gives the better performance demanded by its potential users. It's the most advanced meter body available today, with important advantages never before found in flow and liquid level meters.

***Some of its outstanding features:***

**Sensitive and accurate**—Sensitive to within 0.05% of full scale ... calibrated accuracy ±0.5% of full scale.

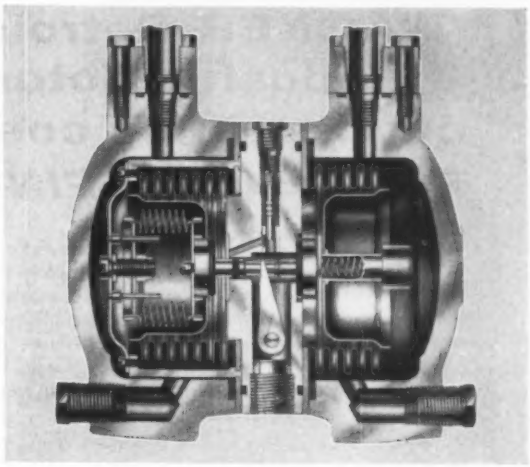
**Leakproof**—Between liquid fill and process fluid.

**Automatically stabilized**—Changes in meter body temperature or static pressure have no effect on output shaft position. The Honeywell Bellows Meter operates efficiently in surrounding temperatures of minus 40°F to plus 250°F.

**Unmatched convenience features**—Including fast range changing in the field ... connections for both horizontal and vertical piping ... quick calibration and adjustment ... easy cleaning and servicing.

**High corrosion resistance**—Seamless, stainless steel formed bellows give long, trouble-free service with virtually all process fluids.

**Fast, effective damping adjustment**—New type pulsation check with rectangular orifice enables essentially linear damping adjustment ... and you can adjust from outside the meter body during operation.



Models are available in many ranges, for both flow and liquid level measurement and control. Get details on *all* the features of the new Honeywell Bellows Meter by calling your nearby Honeywell field engineer today ... he's as near as your phone.

MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa.

**REFERENCE DATA: Catalog C22-1**

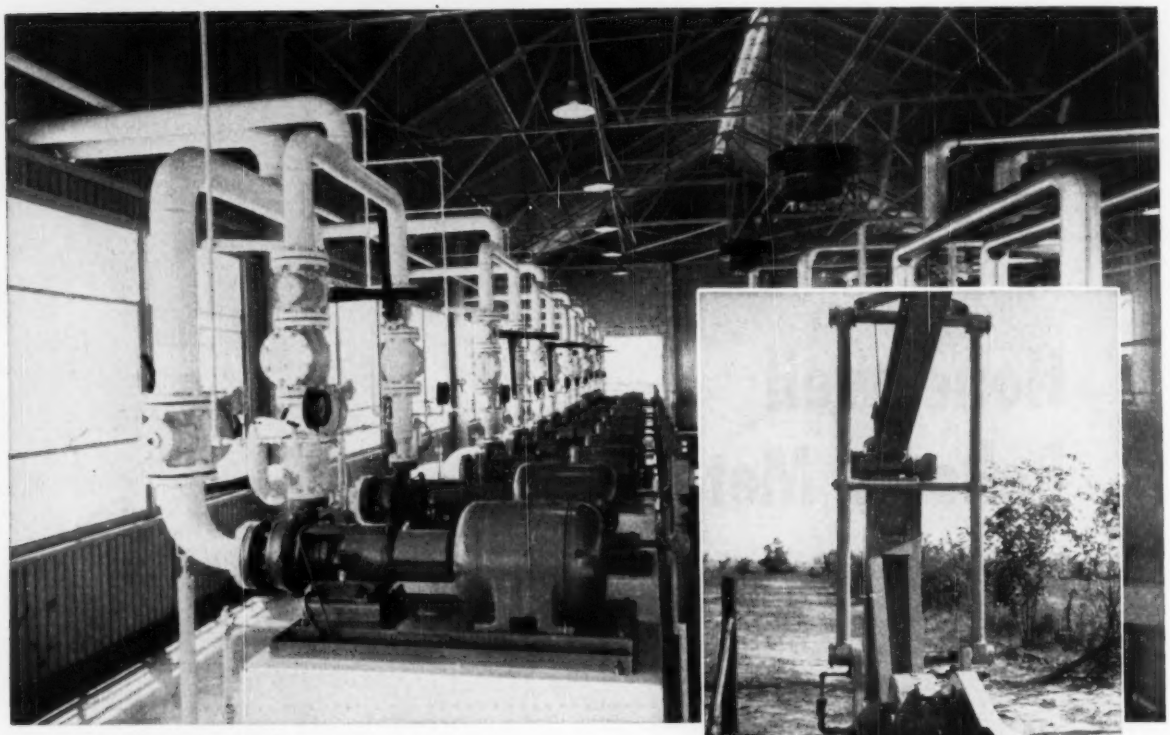
**Honeywell**

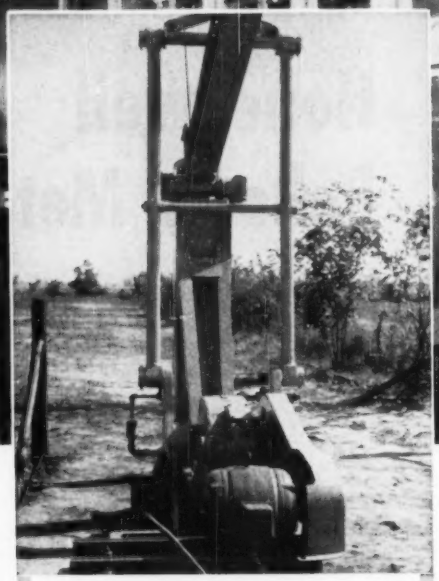
First in Control



For more data on advertised products, use Readers' Service Cards, last page.

Wagner ELECTRIC MOTORS...
*THE CHOICE OF LEADERS IN THE PETROLEUM INDUSTRY*



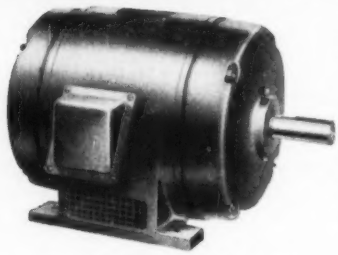


# WAGNER Petroleum Industry Motors cut operating costs in *FIELD* and *REFINERY*

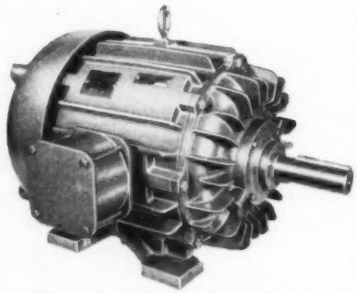
Wagner Type DP and DY Motors are especially designed to meet the load conditions of oil well pumping—to give cost-cutting, year-round, maintenance-free outdoor service. Corrosion-resistant cast iron frames and endplates protect the motor from rain, sand and snow. Conduit boxes are moisture proof and dust-tight. These motors are available for either polyphase or single phase operation. You can get them from stock in your immediate area.

You cut costs when you install Wagner Type JP explosion-proof motors in the refinery because these are built with *extra protection* that means longer motor life: the vital parts of the motor are sealed against dust, fumes, and moisture—the cause of most motor maintenance problems. These motors are approved for Class 1, Group D hazardous locations.

For full information, write for Bulletins MU-224 and MU-137, or phone your nearby Wagner branch office.



Type DP or DY oil well pumping motor. Single phase or polyphase.



Type JP standard totally-enclosed, in ratings through 250 hp; and Type ZP tube ventilated, in ratings through 500 hp.

WM59-1

**Wagner Electric Corporation**
6458 PLYMOUTH AVENUE, ST. LOUIS 14, MO., U. S. A.
BRANCHES AND DISTRIBUTORS IN ALL PRINCIPAL CITIES

ELECTRIC MOTORS • TRANSFORMERS • INDUSTRIAL BRAKES
AUTOMOTIVE BRAKE SYSTEMS—AIR AND HYDRAULIC

# Gasoline Plant . . .

## Built With An Eye To The Future!

This modern absorption-type gasoline plant*, like most modern plants of today, was built with an eye to the future . . . with later expansion in mind.

Currently stripping 100 MMSCF of natural gas per day of propane, iso-butane, normal butane and natural gasoline, it can be quickly and inexpensively expanded to handle an additional 50% of its present capacity.

One very important reason for this plant flexibility was the incorporation in its design of wide range and capacity controls, such as BS&B Super 70 Control Valves, Liquid Level Controls and Regulators.

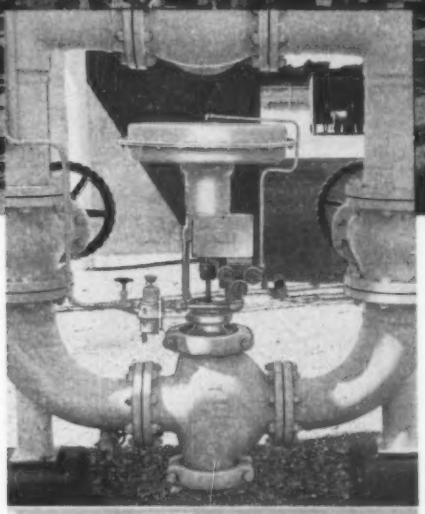
BS&B Controls are everywhere proving themselves in many different oilfield and other applications the world over. Why not specify them on your next job!

* Name and location supplied on request.

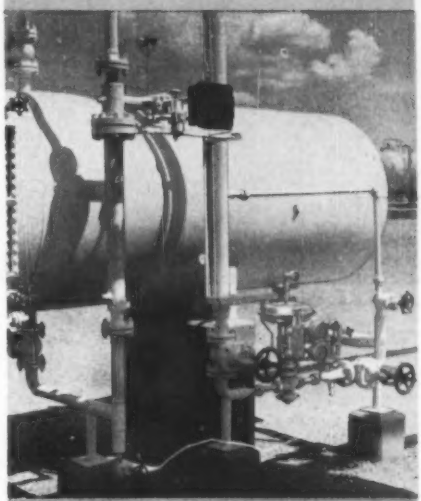
SUPER BS&B 70

**BLACK, SIVALLS & BRYSON, INC.**

Controls Division, Dept. 4-F1
7500 East 12th Street Kansas City 26, Missouri



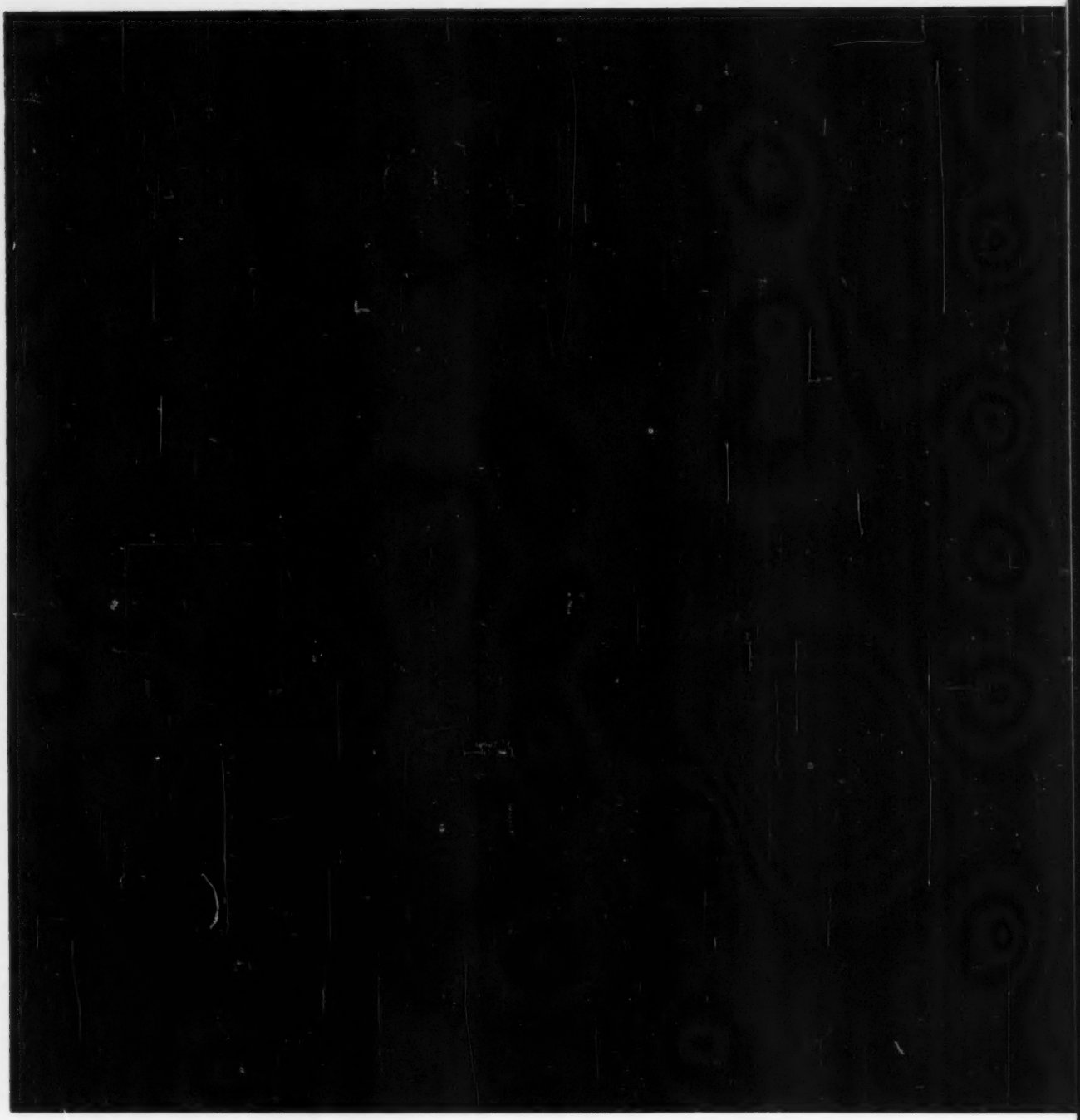
This 6", 150 lb. Super 70 serves as an accumulator pressure control valve. It is equipped with a direct acting actuator and valve positioner.



Butane splitter reboiler equipped with a BS&B Type 71-06 Series 2 Liquid Level Controller with automatic reset relay and a 1" Super 70 valve.



For more data on advertised products, use Readers' Service Cards, last page.



# THE 69½ FEET THAT REACH THE MOON

From a hole no deeper than that, drilled in Pennsylvania 100 years ago, have come endless miracles of oil.

Today, petroleum gives us fuels that are capable of moving man from earth to the moon and beyond. Such explorations can bring new knowledge of incalculable value.

But no less certain than that we will one day fly through space is that we will have ever better fuels and lubricants for travel on the ground, on the sea and in the air – new and exciting products for the farm, industry and the home.

Today one quarter of all the money spent by U.S. industry on research is spent by the petroleum industry.

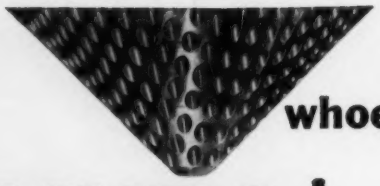
And as chemists study the endless ways to re-arrange oil molecules to make useful products, we can see that the age of petroleum has only begun.

**Standard Oil Company (New Jersey)** ESSO

OIL'S FIRST CENTURY
-BORN IN FREEDOM
WORKING FOR PROGRESS



For more data on advertised products, use Readers' Service Cards, last page.

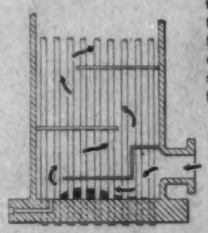


# whoever heard of a conical tube sheet?

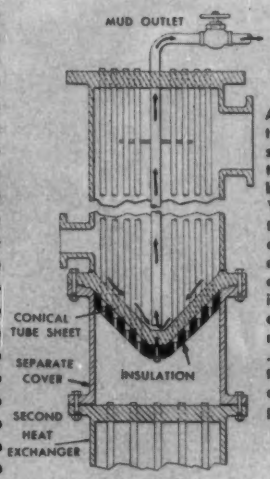
# YUBA! and helped solve ARAMCO'S problem

## THE PROBLEM

In the original heat exchanger, shown at left, sludge in the cooling water settled on the flat tube sheet, causing corrosion at the tube joints. A stepped baffle to increase water velocity across the tube sheet and a connection to blow away the sludge helped only partially. Within one year some tubes failed because of the sludge-induced corrosion.



ARROW ⟵ INDICATES FLOW OF WATER

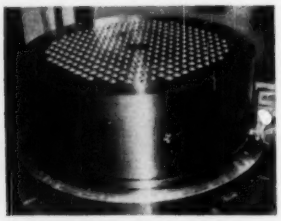



ARROW ⟵ INDICATES FLOW OF MUD

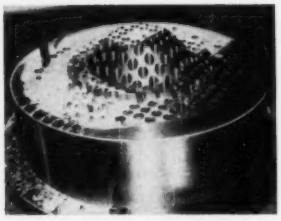
## THE SOLUTION

Aramco believed that a conical tube sheet would permit the sludge to settle to the apex of the cone, where it could be blown from the exchanger. Yuba's experience quickly solved the fabrication details. Because of abrasive particles in the fluid coming from the bottom heat exchanger, ferrules were placed in the tubes and erosion-resistant insulation around the ferrules to protect the tube ends . . . the whole job, an illustration of Yuba cooperation with client engineers to reach a practical solution of a problem.

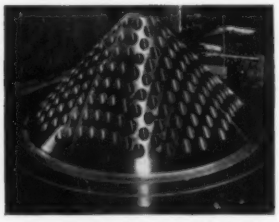
## PRODUCING THE CONICAL TUBE SHEET—THE INGENIOUS PART OF THIS YUBA HEAT EXCHANGER



A forged tube sheet conical both inside and out could not have been drilled because there would have been no purchase for the drill. So Yuba started with a forging which was flat outside and conical inside and then drilled holes on the flat outside surface.



The outside conical surface takes shape as unwanted metal is cut away. When the previously drilled holes became shallow, the drill was reinserted and the holes made deeper. Then more metal was cut away. This process was repeated until . . .

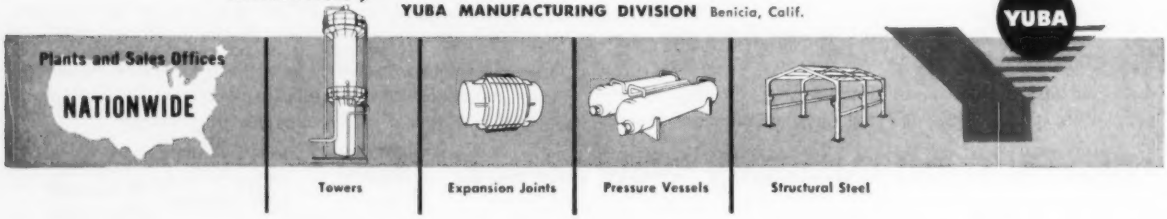


. . . the conical tube sheet was finished. The tube sheet was placed in the Yuba heat exchanger, tubes inserted and welded to sheet. Then replaceable ferrules and insulation were used to protect the tube ends from erosion . . . truly an engineered heat exchanger.

## YUBA CONSOLIDATED INDUSTRIES, INC.

Heat Exchangers designed and manufactured East and West

**YUBA HEAT TRANSFER DIVISION** Honesdale, Pa.
**ADSCO DIVISION** Buffalo, N. Y.
**YUBA MANUFACTURING DIVISION** Benicia, Calif.



# BUYING GUM INHIBITORS?

## Eastman bulk handling system can cut your gasoline-treating costs

BULK shipment means savings.

In the case of Tenamene 2—six cents per pound.

Applied to a 28,000 pound tank truck, this adds up to $1,680. On a 36,000 pound tank car, $2,160.

By buying Tenamene gum inhibitors in bulk, you eliminate drum handling and storage costs, too.

Still another advantage is that the 3-compartment tank truck permits you to receive as many as three different Tenamene additives in one shipment with bulk prices applying to each one.

Eastman's bulk handling service is practical primarily for refiners whose inhibitor requirements justify modification or replacement of existing drum handling and storage facilities.

To help you evaluate the economics of Eastman's bulk handling system in your operation, we have prepared a comprehensive and detailed description of the fittings, transfer lines, storage installations and procedures required.

This on-the-spot engineering assistance on planning a bulk handling installation plus technical advice on the proper and economical use of Tenamene additives is available from our local representative. Write or call any of the sales offices listed below, or contact EASTMAN CHEMICAL PRODUCTS, INC., subsidiary of Eastman Kodak Company, KINGSPORT, TENNESSEE.

# Tenamene

EASTMAN GASOLINE ADDITIVES

**SALES OFFICES: Eastman Chemical Products, Inc.,** Kingsport, Tenn.; Atlanta, Ga.; Chicago; Cincinnati; Cleveland; Framingham, Mass.; Greensboro, N.C.; Houston; New York City; St. Louis. **West Coast: Wilson Meyer Co.,** San Francisco; Denver; Los Angeles; Phoenix; Portland; Salt Lake City; Seattle.



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# Tailor-made, tough and chemically inert...

## *. . . these J-M Chempac Teflon* components combat chemical and solvent action!*

SMALL OR LARGE . . . intricate or simple . . . J-M Chempac® Teflon components have proved their exceptional resistance to the constant attack of corrosive chemicals in rugged service.

Look to J-M for Teflon packings, gaskets, and moulded shapes made to your exact specifications . . . or for parts that are machined to close dimensional tolerances. Moreover, we can combine Teflon with top quality J-M asbestos to impart the exceptional sealing and heat-resistance properties of the "magic mineral." And in addition to corrosion-resistance, Teflon gives you the advantages of an extremely low coefficient of friction . . . toughness and flexibility . . . and weight-saving possibilities.

You can also obtain J-M Chempac Teflon Packings in moulded and braided types for pumps and valves . . . in a wide range of flange and envelope-type gaskets . . . in rings, cups, sheets and tapes. Your J-M Packings Distributor can supply your needs. Or write Johns-Manville, Box 14, New York 16, New York. In Canada: Port Credit, Ontario.

*TM for DuPont Tetrafluorethylene resin.

**Teflon rods, tubes, tapes and sheets** —in addition to components of varied sizes and shapes as indicated here—are also available from Johns-Manville. Prompt delivery of any quantity you need is assured by new J-M production facilities.

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**JOHNS-MANVILLE**

100 YEARS OF QUALITY PRODUCTS . . . 1858-1958

# Marsh Mastergauge

## ...the gauge that has everything!

**LEAK-PROOF ONE-PIECE CONSTRUCTION** from socket to tip of bourdon tube...accomplished by the exclusive Marsh "Conoweld" process.

**STURDY "MARSHALLOY" CASE** formed of boiler-plate thickness steel, copper clad inside and outside by "Marshalloy" process to give it all the durability and the corrosion resistance of solid copper with the dependable strength of steel.

**SUPERLATIVE "MASTERGAUGE" MOVEMENT** with exclusive "coined" sector gear, self lubricating, frictionless action and other refinements that add years to service life.

**TYPES FOR EVERY SERVICE**...wide range of bourdon tubes including stainless steels and monel. Full range of pressures, vacuum, compound gauges in endless sizes, case styles. Only Marsh has the "Safecase" for dangerous gauge applications.

"Mastergauge" is standard bearer for the broad line of Marsh Gauges fully covered in Catalog 76-G. All are available with the "Recalibrator" —best way to correct a gauge that has been knocked out of adjustment.

**MARSH INSTRUMENT CO.**
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"THE STANDARD OF ACCURACY"

GAUGES • DIAL THERMOMETERS • REFRIGERATION INSTRUMENTS • HEATING SPECIALTIES


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# NOW!
## RESEARCH-GRADE
# METHANE
## IN INDUSTRIAL VOLUMES

***"We've never had such good Methane for our processes . . .***

IN fact, we did not think it possible to get Methane with so little $C_2$ in it," reports an official of a large American chemical plant now operating one of Air Liquide's low-temperature Methane units.

Methane purity of a very high order is a must when it is the starting point for the production of insecticides, grain fumigants, aerosol bomb propellents, and other chlorinated products.

Methane produced from Air Liquide low-temperature units will easily meet the specification "less than 100 ppm of total hydrocarbons."

If high-purity Methane is one of your requirements, we invite you to consult with us.

All American Air Liquide low-temperature separation plants owe their top-notch efficiency, economy of operation, and maximum output performance with minimum labor requirements to over half a century of design and engineering experience in this specialized field.

*Thousands of Air Liquide plants of every type are in use throughout world industry. Here are some of them:*

- Air Separation — oxygen, nitrogen, and rare gases
- Coke-Oven Gas Separation
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# Pays for itself in Savings!

NO LEAKAGE
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NO STUFFING BOX

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### CONTROLLED-VOLUME CHEMICAL PUMP

The moment your new Pulsafeeder is put into operation, you're on the way to real savings . . . savings that can eventually result in the Pulsafeeder paying for itself.

Lapp Pulsafeeder, the chemical pump with *no stuffing box*, is a piston-diaphragm pump providing *positive displacement* by a piston pumping a hydraulic medium working against a diaphragm. The diaphragm isolates the chemical being pumped from the working pump parts . . . eliminates need of stuffing box or running seal . . . prevents corrosion. Maintenance costs are reduced to next to nothing—there are practically no repairs or replacement of parts with a Pulsafeeder. You'll save, too, by elimination of product loss due to leakage or contamination. In the long run, Pulsafeeder is the safest, surest and lowest cost controlled-volume chemical pump. To prove our stand, we'll be happy to quote actual maintenance costs taken from recorded case histories.

**WRITE FOR BULLETIN 440** *with typical applications, flow charts, description and specification of models of various capacities and constructions. Inquiry Data Sheet included from which we can make specific engineering recommendation for your processing requirement. Write Lapp Insulator Co., Inc., Process Equipment Div., 3405 Poplar St., Le Roy, N. Y.*

**Lapp**




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# Rockwood Double Strength Foam

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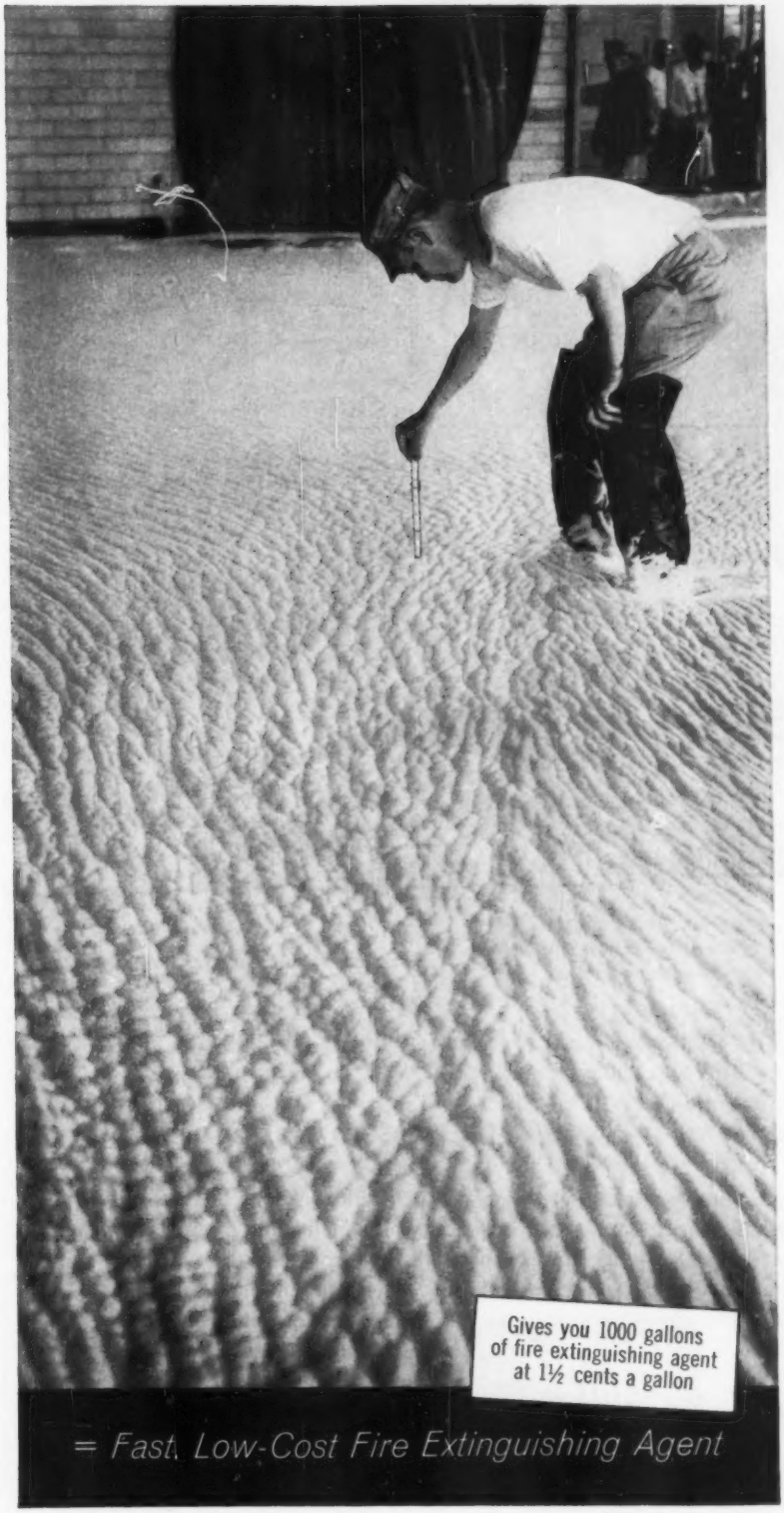
# Adds Up To SAVINGS




**Rockwood Double Strength FOAM liquid** binds large volumes of air and water into a fast, inexpensive fire extinguishing agent. It can save you hundreds, even thousands of dollars in the cost of your fire fighting materials.

If you use other types of fire extinguishing agents — you're paying for 100% of the extinguishing agent, plus storage and shipping. With Rockwood FOAM you're paying for only 3 tenths of 1% and *shipping costs are less — storage costs greatly reduced!*

Get all the money-saving facts. Send in the coupon below for complete information. Tested and listed by Underwriters' Laboratories, Inc. Distributors in all principal cities.

**ROCKWOOD SPRINKLER COMPANY**

***Engineers Water***

***. . . to Cut Fire Losses***

ROCKWOOD

**ROCKWOOD SPRINKLER COMPANY**
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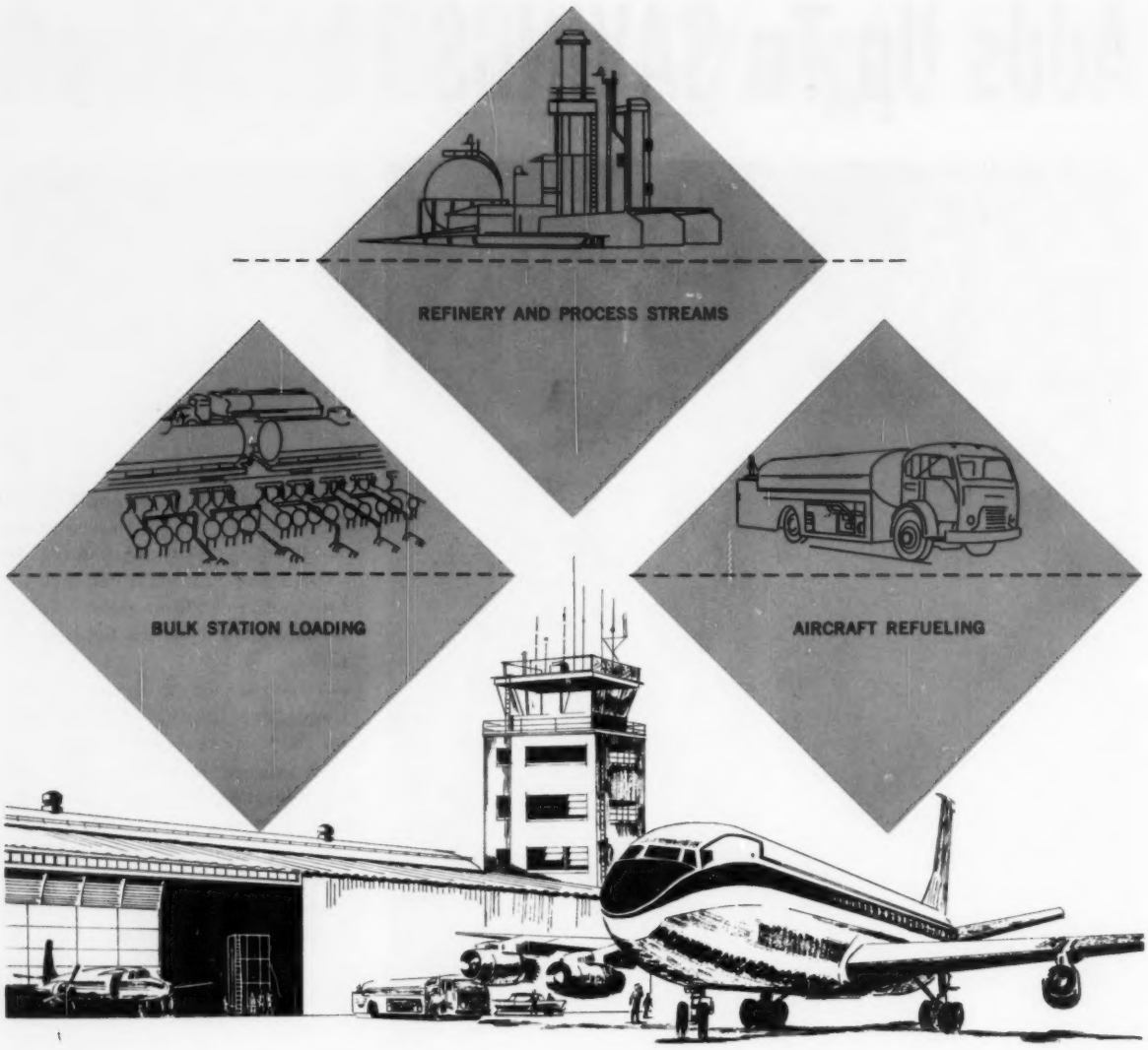


# CONVERT EXCELSIOR PACK SEPARATORS

## *fast, economically with* WARNER LEWIS *conversion kits*

This new kit converts your existing excelsior packed separators into high efficiency filter/separators for removal of fine solids and emulsified water in finished petroleum products. In today's exacting requirements in refinery processing, bulk station loading and jet aircraft fueling, it is most important to have clean, dry products. Since Warner Lewis Company is the original manufacturer of excelsior-type separators, our complete files insure correct fit of conversion kit and maximum efficiency of operation at lowest possible cost. Write us today for complete information on your requirements.

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DIVISION OF FRAM CORPORATION



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## The Mail Box . . .

### Look Like Record?

To the Editor:

We, the employes of the Yorktown, Virginia, four-drum coking unit, are seeking information about refinery record runs to see if we have not in fact set a new record run for a Delayed Coker.

We employes of American Oil Company were assigned to a new four-drum coker built by the Lummus Co., in 1956, and put on stream in January, 1957. We are now in run No. 4, and as of today, have been on stream 240 days without even a partial shutdown. During this run we have averaged approximately 17,000 b/d through the furnace which is more somewhat than design, and to us means that we have not babied the unit for a long run.

The employes of this unit read your magazine and enjoy it very much and would appreciate it very much to see us recognized in your magazine for this accomplishment.

We would appreciate it very much if you will notify us as soon as possible whether we have or have not established this record and, if not, just what the record is.

Howard D. Rogers,
Operator
Yorktown, Va.

*Editor's Note:—If anyone has beaten this delayed coker record, let us know.*

### Timely Article

To the Editor:

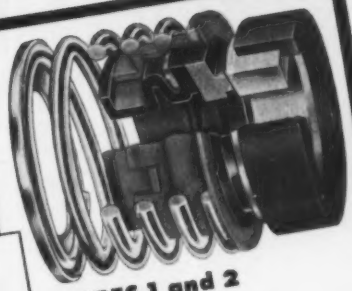
Thank you for the reprints of the article "How DuPont Handles Alcoholics" (November PR, page 329). I will put these to what I hope will be good use. You are to be complimented on printing this timely article in your November issue.

J. Collis Ringo
Executive Director
Kentucky Commission on Alcoholism
Frankfort, Ky.

**PETROLEUM REFINER welcomes letters of comment dealing with timely topics pertinent to the oil, gas and petrochemical processing industry. Keep 'em short! Address The Editor, Box 2608, Houston 1.**


Reduce your liquid handling costs!

Install JOHN CRANE



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MANY ACIDS
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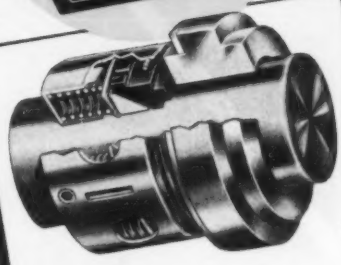

TYPE 9
EXPENSIVE CHEMICALS
CORROSIVES
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SOLVENTS
TOXICS

MECHANICAL SEALS

There is no better way to cut liquid handling costs than with "John Crane" Seals. They are specially engineered for the Chemical Industry to provide these important operational savings:

1. **Eliminating loss of expensive and corrosive fluids.**
2. **Positive sealing of toxics, thus minimizing need for costly exhaust equipment.**
3. **Substantially reduced maintenance and the man-hours involved.**
4. **Reduction of "shutdown periods" due to materially increased service-life expectancy over and above your present methods.**

Ranging from the Types 1 and 2 (for services where synthetic rubber is suitable) to the Type 9 (with sealing members made of DuPont Teflon to handle any industrial chemical or corrosive) . . . there is a "John Crane" Seal that can be adapted to your individual conditions.

**remember:** **Your toughest problem can be "John Crane's" next success story.**

*Don't wait, call us now. Get our seal catalog . . . . .*

Crane Packing Co., 6420 Oakton St., Morton Grove, Illinois (Chicago Suburb).
*In Canada: Crane Packing Co., Ltd., Hamilton, Ont.*

John Crane
CRANE PACKING COMPANY




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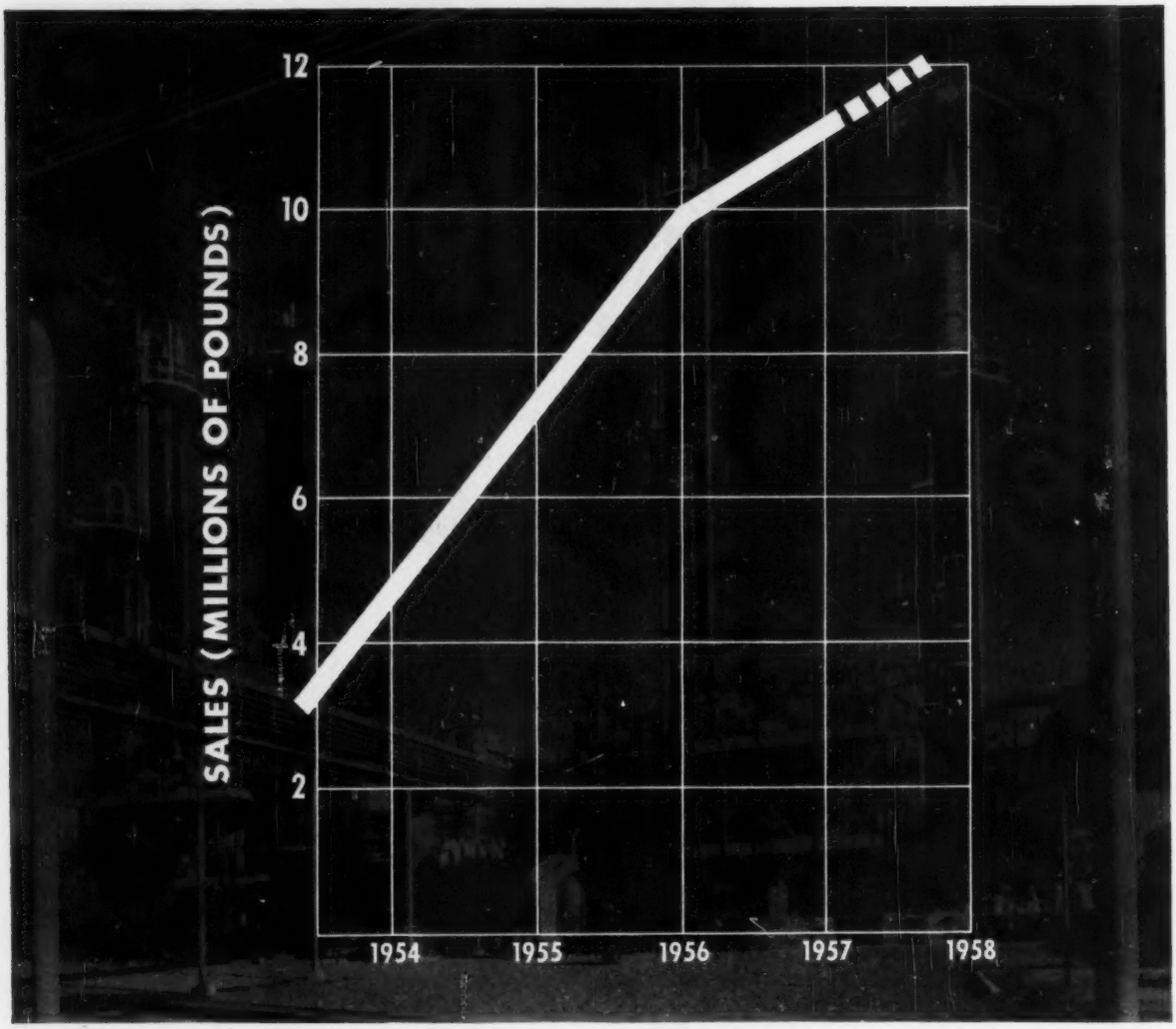


# GOVERNMENT FIGURES PROVE AMAZING GROWTH OF DALPAC-TYPE ANTIOXIDANTS

Figures of the U. S. Tariff Commission show the astounding growth of di-tert-butyl-p-cresol in just three years—almost tripled!

Dalpac 4, Hercules di-tert-butyl-p-cresol, has firmly established itself as a leading antioxidant in many industries where hydrocarbon stability is a problem. Petroleum refiners, for example, rely on Dalpac to inhibit gum formation, stabilize gasoline color and prevent engine deposits. They use it in turbine and transformer oils to prevent deterioration. Dalpac 4 has no effect upon electrical properties, which makes it ideal for use in transformer oils.

These are but a few indications of where this Hercules antioxidant can serve you. Since Hercules is a basic integrated producer starting with the raw material, you can count on a dependable source of supply. We will be glad to answer your inquiries and send technical information.

**DALPAC® 4**

*Oxychemicals Division • Naval Stores Department*
**HERCULES POWDER COMPANY**
INCORPORATED
*900 Market Street, Wilmington 99, Delaware*

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# Houdry means Progress

## ...*through Catalysis*

Houdry has had 30 years of continuous activity in the development and design of catalytic processes and catalysts. It has accumulated experience, know-how and facilities unmatched in its field.

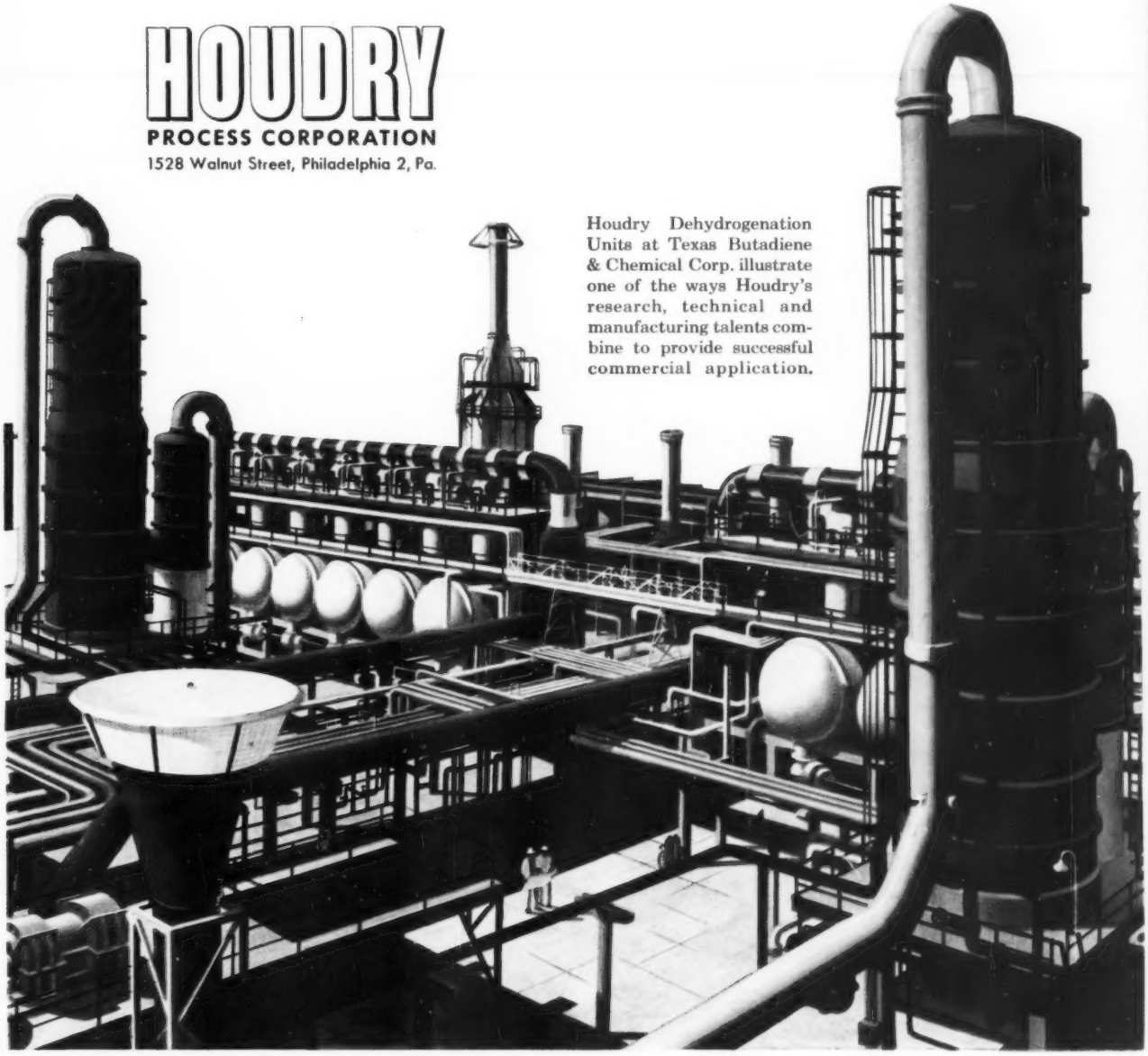
Whenever problems arise concerning catalysis, Houdry is in a position to provide the best possible solutions—because Houdry—

- Designs and licenses catalytic installations throughout the world
- Manufactures and supplies a variety of catalysts for established processes, as well as special purpose catalysts tailored to specific individual requirements.
- Provides technical service to assist in selection of catalysts and operation of processes
- Offers contract research to assist in the development of individual processes and products . . . through catalysis

Today, Houdry is accelerating the development of new and improved catalytic processes and catalysts for even more efficient—and profitable—processing than ever before.

In solving the many catalytic problems brought to us, we may already, in essence, have solved yours. Consult with us.

**HOUDRY**
**PROCESS CORPORATION**
1528 Walnut Street, Philadelphia 2, Pa.



Houdry Dehydrogenation Units at Texas Butadiene & Chemical Corp. illustrate one of the ways Houdry's research, technical and manufacturing talents combine to provide successful commercial application.



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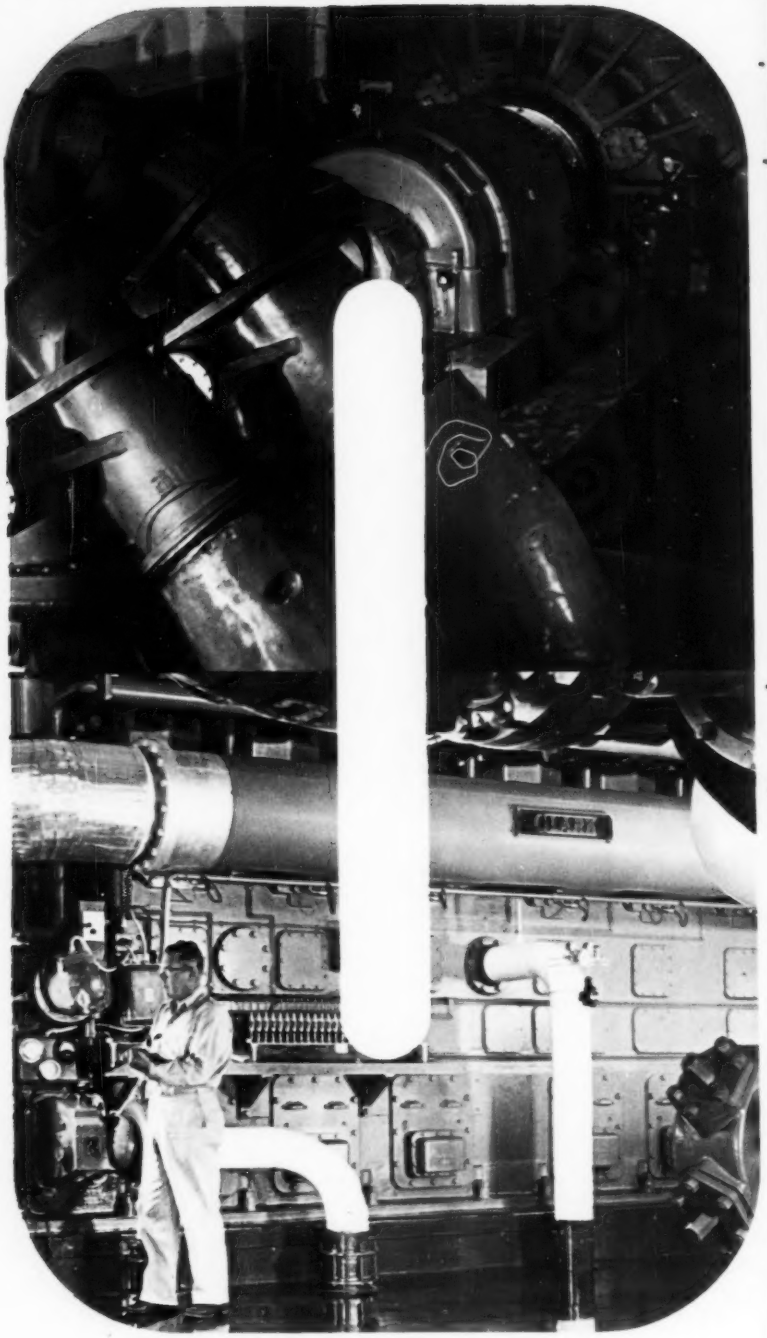

FOURTEEN DRESSER OPERATING COMPANIES SERVE THE WORLD-WIDE OIL AND GAS INDUSTRY WITH

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advanced scientific research

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PACIFIC PUMPS, INC.
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ROOTS-CONNERSVILLE BLOWER DIVISION
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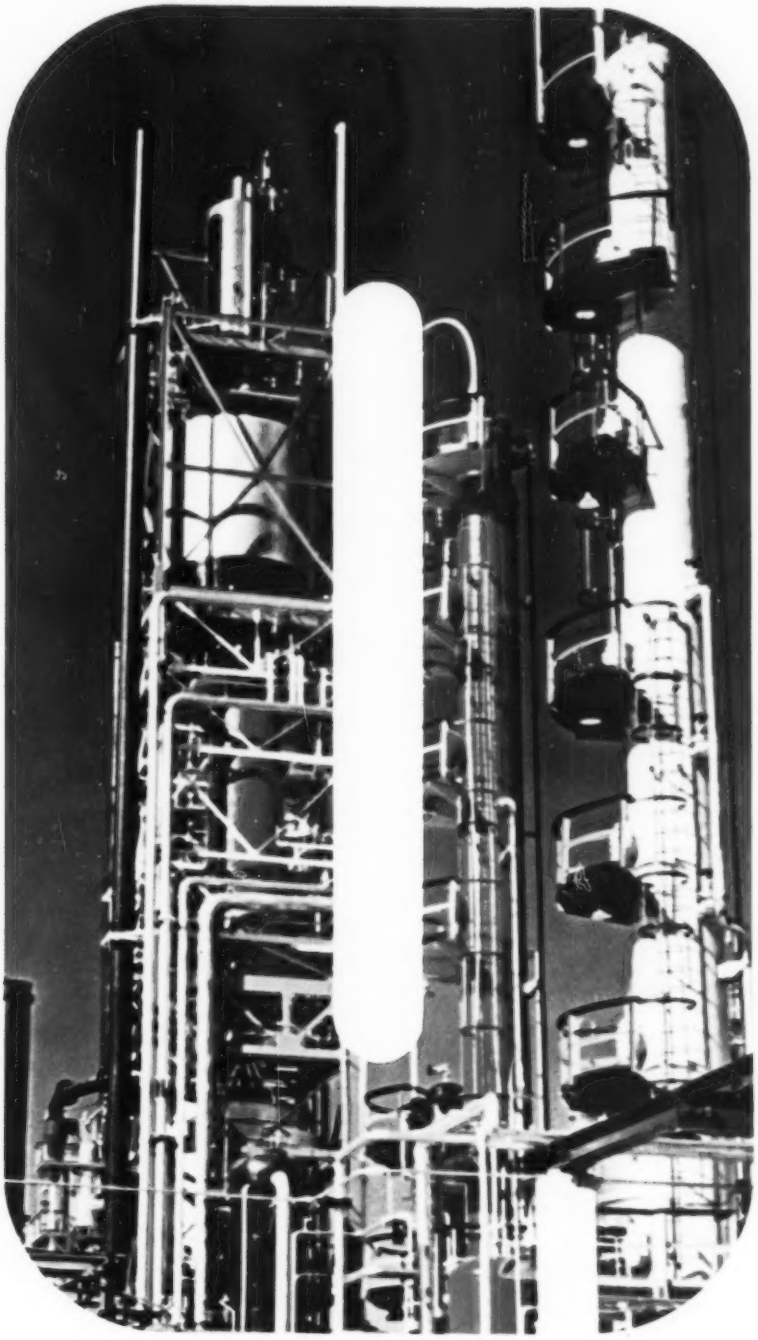
SECURITY ENGINEERING DIVISION—drilling bits



Dresser Industries salutes the Petroleum Industry and its next century of progress and pays tribute to the industry's many fine accomplishments during its first one hundred years of service.

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WELL SURVEYS
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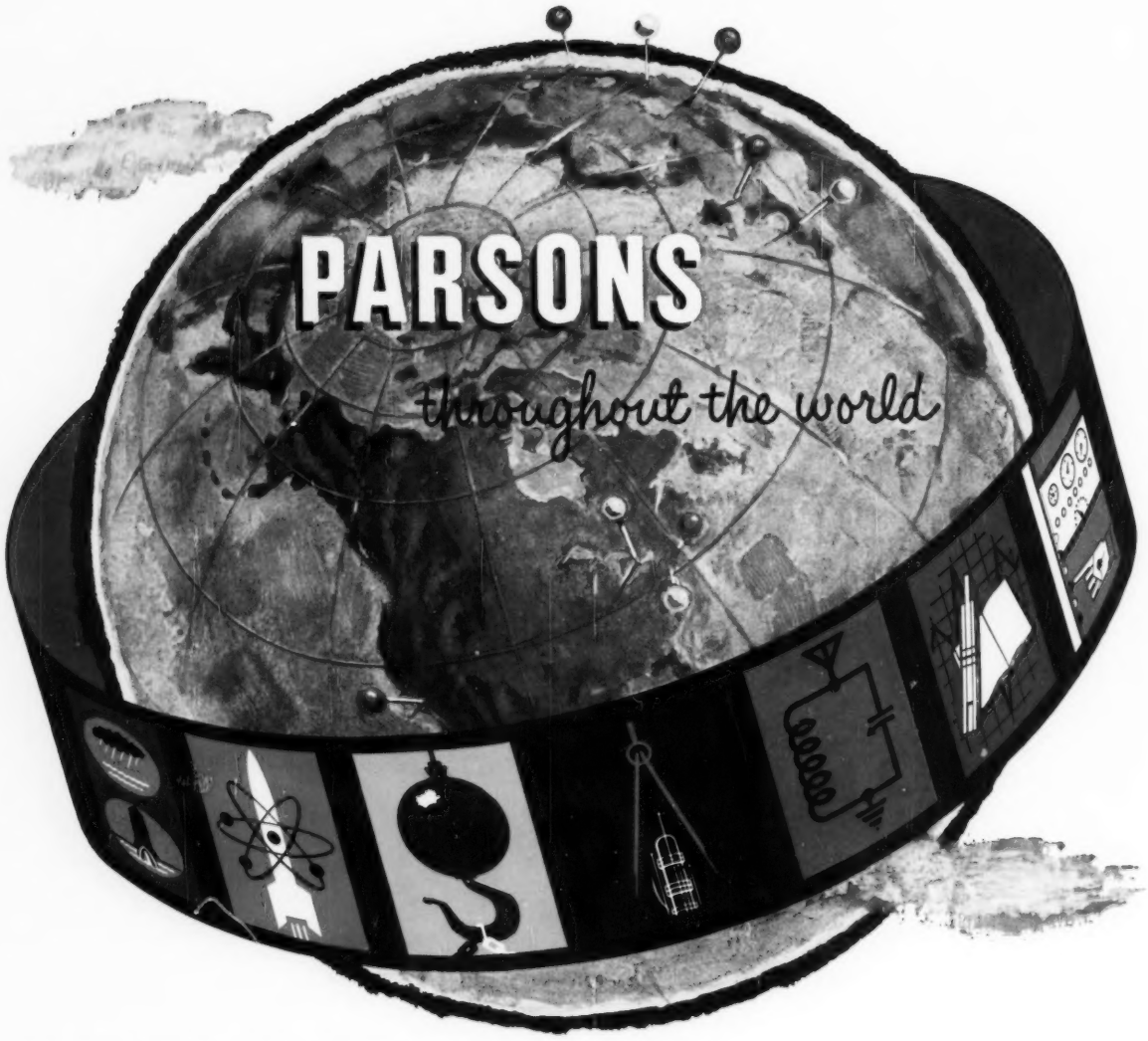


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**THE RALPH M. PARSONS COMPANY PROVIDES...**

**These Services**—Process Design • Engineering and Drafting • Procurement • Construction • Operation of Technical Facilities • Appraisals and Economic Studies • Research, Development and Manufacturing of Electronics, and other Devices and Systems.

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# FOREWORD

THE history of oil is fascinating, dramatic and at times exciting. It is the story of a discovery at Titusville, Penn., 100 years ago which set the hearts of men to burning—a story which started a rush paralleled only by the stampede of gold-hungry forty-niners ten years earlier.

It is the story of men who had the vision to understand that oil had been beneath the earth's surface for millions of years without contributing materially to man's mode of life. And even as it flowed from their wells, they realized it was valuable and useful only in terms of what could be taken from it . . . and thus the refining industry was born in a concept.

This volume is the story of how that concept was grasped by men of vision and molded into reality—of how they took this form of energy which Colonel Drake had released and harnessed it for mankind.

It is divided into three chapters with Chapter 1 telling The Refining Story, The Natural Gasoline Story, and The Petrochemical Story—three facets of oil history which have etched indelible impressions upon the development of American industry.

Chapter 2 is concerned only with the men of those histories—more specifically, the eight individuals who have contributed the most to the Oil, Gas and Petrochemical Processing industry. Together they form the first Refining Hall of Fame.

In Chapter 3 we have gone further than you might normally expect. In addition to covering the past 100 years of Oil, Gas and Petrochemical Processing, PETROLEUM REFINER is extending your vision by 25 years —to the year 1984. In this chapter you get a clear picture of what the world energy sources will be at that time and how extensively each will be used. You will also read how the chemical industry expects to utilize oil within this 25-year period; how new training challenges will affect management; and about a dramatic new concept in engineering education.

The three chapters in this volume give you an all-round look at our industry—the industry which has enabled man to conquer time—and now, space.

PETROLEUM REFINER Staff

## Chapter 1: The Past

# THE REFINING STORY

**Clayton A. Umbach, Jr., and Harold L. Hoffman**
Petroleum Refiner Staff

THE STORY of petroleum refining is a shining chapter in the history of the world. It's one that combines vast wealth with scientific achievements; fierce competition with high adventure; and shady deals with lofty ambitions. But behind this march through time there lies the hopes of visions of many men which combined to create and mould a new industry—oil refining.

The history of the refining industry goes back many centuries before Colonel Drake successfully drilled the first well at Titusville in 1859. For instance, one of the earliest sites of oil refining was on the shores of the Caspian Sea. Oil was transported to the refineries in arbas, Persian carts with nine-foot wheels. A barrel of oil was mounted on the axle of the cart, and a second slung beneath. Distillation changed the black naphtha to a bright yellow "spirit" which was readily inflammable.

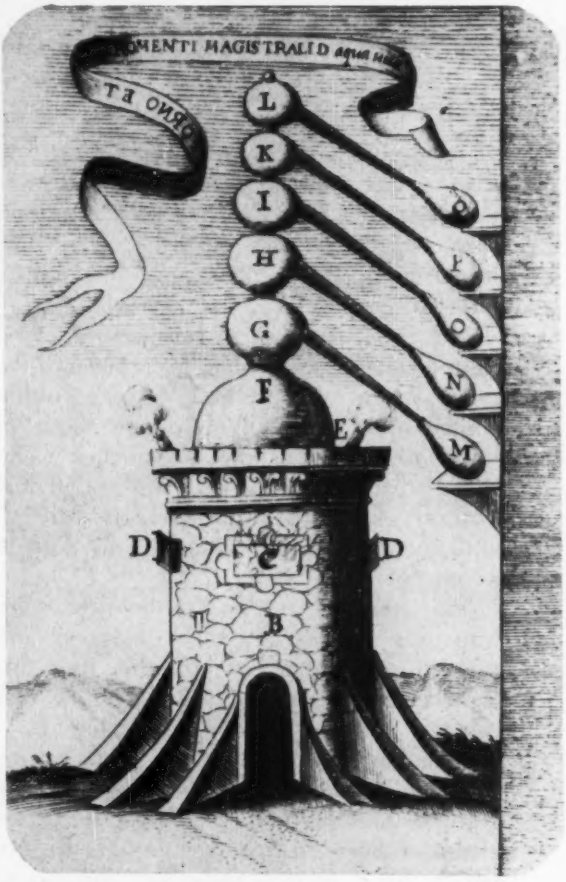
**Early Principles.** The fifteenth and sixteenth centuries also provide some interesting contributions to types of apparatus used. Actually, the alchemists of that day were quite advanced when you consider they were working before the dawn of science. Many of the principles which are fundamental in the design of present-day distillation apparatus were widely employed in alchemical practice. Among these principles are:[1]

1. Side streams from a fractionating tower.
2. Refluxing.
3. External regulation of still-head temperature.
4. Reboiling of condensates for increased fractionation.
5. Preheating liquid before distillation.
6. Feeding liquid into the still while in operation.

It is apparent the alchemists had an extremely high regard for the powers of the distillation process. In 1553, Porta wrote:

> "Now we speak of oyls; these require the industry of a most ingenious artificer, for many of the most excellent essences of things do remain in the oyl so close that without the greatest art, wit, cunning, and pains they cannot be brought to light; so that the whole art of distillation dependth on this."[2]

**Distillation Use.** As early as 1555, the alchemists recognized that in the distillation of liquids, particularly when using the bubble tower of the reflux, condensate is necessary. This is demonstrated by the fact that Philiatrus showed still with reboilers. The alchemists also knew how to produce a number of distillates in one operation.




**The Ancients in distilling oils and other substances often produced a number of distillates in one operation. This bulb-type tower from the 1600s collected five separate distillates.**

As a possible word of caution to those inexperienced to working with "oyls," Porta added this final note:

> "If you distill common oyl, it will hardly run. You must be very careful that the ashes and pot do not wax too hot, for if the oyl within takes fire it will break the vessels and flie up, that it can hardly be quenched, and reach the very ceiling; so that it is best to operate upon oyls in arched rooms."

## THE VISION OF ONE MAN

Perhaps one of the least hallowed heros of the refining industry is Samuel Martin Kier. It was due largely to the contributions of Samuel Kier that the world wide quest for oil began, and it is to his achievements that today's great refineries must trace their origin.

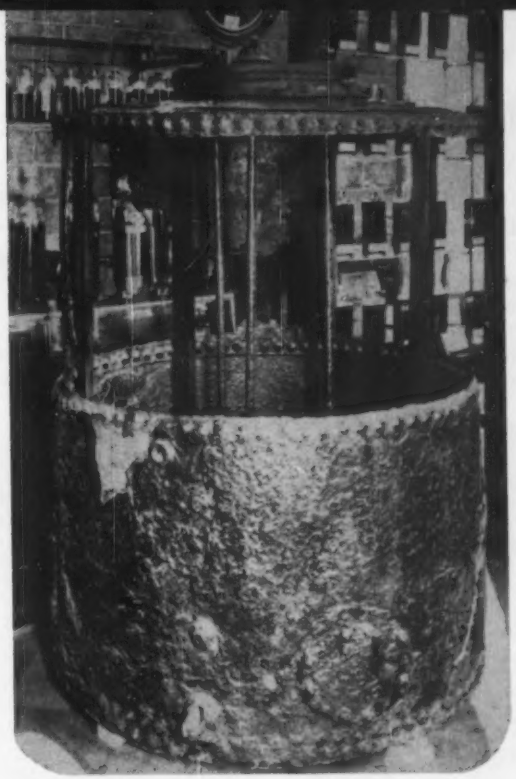
As early as 1839, Sam Kier helped his father in drilling salt wells near Tarentum, Penn. Around 1844 or 1845, however, the future of Tarentum's salt industry began to look dim. Along with the brine, wells in the area had started producing petroleum in the form of a thick sticky sludge. Of course, the commercial value of this petroleum was unknown; therefore, the intruding product was considered a nuisance. The brine had to be collected in tanks so the oil which rose to the top could be drained off onto the ground or into the nearby canal. Almost everybody considered the messy stuff worthless and much of it was wasted before a happy accident proved it of some value—if only limited.

**A Lucky Accident.** One day some boys in Tarentum threw a burning brand into the canal, with the result that the whole canal for half a mile or more began to burn. The people quickly realized it was the oil they were draining into the canal which was burning. From then on they took advantage of the new product's properties by burning it in their lamps. Although it gave off much smoke and had quite an offensive odor, it afforded good light—and, above all, it was free.

Thus, as early as 1846, Tarentum was perhaps the first community in the country to use petroleum extensively as a means of lighting its homes and shops. It was at that time that Samuel Kier began mulling over the possibilities of this new petroleum.

**The "Cure-All."** At a loss as to how he could best exploit its commercial value, Kier introduced it in 1846 as "Petroleum or Rock oil . . . the most wonderful remedy ever discovered . . . " and thereupon described the many body ailments it would cure. Although his "cure-all" found quite an enthusiastic market, it was nevertheless rather limited so he turned his attentions to other possible applications.

To find out more about oil, Kier sent a sample for analysis to J. G. Booth, a Philadelphia chemist, who recommended that it be offered to a New York firm as a gum solvent. This, however, proved to be unsatisfactory. Booth then suggested it probably would make a pretty good illuminant if it could be distilled, and he supplied Kier with drawings of a still which he thought might prove suitable for this purpose. Acting on this recommendation, Kier returned to Pittsburgh. He lost no time in acquiring an iron kettle, cover and worm—and some free advice from a man who worked in a local whiskey distillery. Then built his still—this was the first oil refinery in America.



**Samuel Kier's wrought iron still processed much of the oil from Colonel Drake's first well of 1859. The remains of this still were presented to Pennsylvania State College for display.**

**Many Troubles.** Kier set up his little refinery in a small one-story building at Seventh Avenue and Grand Street, Pittsburgh. In 1854 he produced a refined oil product which he called "carbon oil" and which he introduced to the market as an illuminant. Actually, this refined product was little better than the original crude and still gave off a terribly offensive odor when burned.

Unfortunately, however, Kier had hardly established himself when an explosion and fire threatened to put him out of business. There were also many complaints from the neighbors about the awful stench of the refinery and the city officials decided that, at best, refining was a repulsive and hazardous occupation. They ordered Kier to move outside the city limits and by the time he did so the demand for his refined product had increased substantially.

Meanwhile, his one-barrel still was stolen when it was inadvertently left unguarded for a few moments on a sidewalk. The second still was constructed of wrought iron and was about 42 inches in diameter. It was about 60 inches in height and had a capacity of 5 or 6 barrels. This was the original still used in the refining of much of the oil from Col. Drake's first well of 1859.

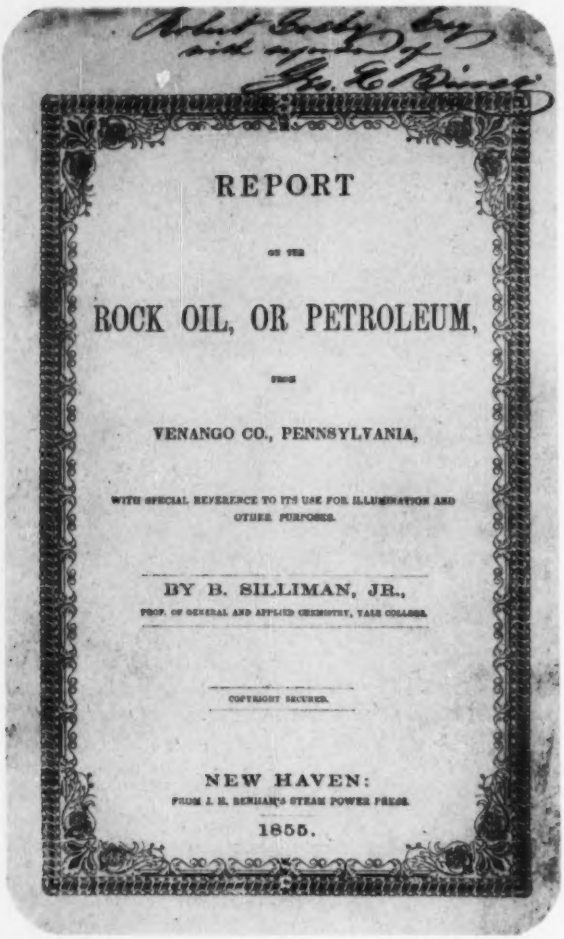
Actually, Kier was never able to remove the odor entirely from this product but he did improve it greatly by distilling each batch a second time.

## A "CHEMICAL CLASSIC"—A NEW INDUSTRY

About one year after Kier had been refining his "carbon oil," a bewhiskered gentleman at Yale University put

the finishing touches to an analytical report that ultimately was called "a chemical classic that touched off an industry." The man was one of the most distinguished scientists of the era, Benjamin Silliman, Jr., professor of general and applied chemistry at Yale University.

It had all started two years earlier in the fall of 1853 when George H. Bissell, a young lawyer in New York City returned to his old home at Hanover, N. H., for a visit. While there, he saw in the office of the Chemistry department at Dartmouth College, a small bottle of petroleum from an oil spring in Venango County, Penn. Upon closer examination he began to get the idea that petroleum could be used quite successfully for an illuminant—providing, of course, a sufficient supply could be found.



REPORT

ON THE

ROCK OIL, OR PETROLEUM,

FROM

VENANGO CO., PENNSYLVANIA,

WITH SPECIAL REFERENCE TO ITS USE FOR ILLUMINATION AND OTHER PURPOSES.

BY B. SILLIMAN, JR.,

PROF. OF GENERAL AND APPLIED CHEMISTRY, YALE COLLEGE.

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NEW HAVEN:

FROM J. H. BENHAM'S STEAM POWER PRESS.

1855.

**In 1855, Professor Silliman's report on the chemical analysis of crude oil gave heart to the pioneers of that era. It has been labeled "a chemical classic that touched off an industry."**

**Destination Titusville.** Bissell was quite excited over the possibilities of the use of oil and upon his return to New York discussed the matter with his partner, Jonathan G. Eveleth. The oil springs where the sample had come from were located on Hibbard farm near Titusville, so the partners decided if an inspection of the farm proved favorable, they would organize a company and buy the land.

Before leaving for Titusville, however, the two men went to New Haven to contact other possible investors for the enterprise. Before making any investment, these capitalists thought they ought to see an analysis of the oil to ascertain its utility and value. This was the stage at which Eveleth and Bissell contacted Professor Benjamin Silliman, Jr.

While professor Silliman was working on the analysis, Eveleth and Bissell proceeded to Titusville to inspect the oil springs. Satisfied that there was enough petroleum, they bought the Hibbard farm on November 10, 1854. Then, on December 30, 1854, they organized the first petroleum company in the world—the Pennsylvania Rock Oil Company of New York.[3]

**Stock Sales Lag.** The two were soon to learn that one of the most difficult portions of their plan was yet to come; the selling of stock in this newly formed company. There was no doubt in the minds of many people that this was a real hair-brained scheme. Hard times had made money scarce and, above all, the state of New York said all stockholders in joint stock companies were liable for all debts of the company. On top of everything else, the two promoters still couldn't tell prospective investors what petroleum was or what it could possibly be used for.

Fortunately, Professor Silliman's report answered these last two questions. His chemical analysis which was completed on April 16, 1855, proved to be quite optimistic and gave heart to the pioneer promotors. The key words from Silliman's report read:

"In conclusion, gentlemen, it appears to me that there is much ground for encouragement in the belief that your company have in their possession a raw material from which, by simple and not expensive process, they may manufacture very valuable products.

"It is worthy to note that my experiments prove that nearly the whole of the raw product may be manufactured without waste, and this solely by a well directed process which is in practice, one of the most simple of all chemical processes."

Ironically enough, publication of Silliman's report was delayed for some time after its completion. Silliman's bill for his services amounted to $526.08 and he placed the complete report in the hands of a friend in New York who was to release it to Eveleth and Bissell only after arrangements had been made for the payment.

**Western Stirrings.** Around this same period of time, the beginning of oil refining was being felt on the West Coast. Actually, this portion of history is subject to speculation, but some accounts say that Don Andres Pico tapped the seepages in Peco Canyon in 1855 and made oil for the San Fernande Mission in a "copper still and worm," but nothing ever came of this.

A small group of San Franciscans are credited with the first serious attempt at refining. In 1859 a group of whale oil dealers began experimenting with samples of

heavy crude which came from a shaft sunk in a brea bed. The goal was a substitute for whale oil but the results were imperfect. In spite of this, however, a 400-gallon "manufactory" was built near the shaft. It was in operation by 1860 but never did prove successful.

### "DRILL FOR OIL!"

While the optimism of the Silliman report did influence a great many investors, sale of stock in the new company continued to lag because of New York's rule of liability of stock holders in a stock company. Eveleth and Bissell decided, therefore, to reorganize their company in the state of Connecticut to avoid that particular law. To do this, they had to abandon the Pennsylvania Rock Oil Co. of New York and organize the Pennsylvania Rock Oil Co. of Connecticut. After a great many legal technicalities, this was finally established and, at the same time, the two men added a note of prestige to the company by making Professor Silliman the first president. For this, he accepted 200 shares of stock.

It is not definitely known whether this next account is fact or legend, but the story goes that during this period of time Bissell was walking down New York's Broadway one summer afternoon and was attracted to the window of a drug store by an imitation greenback advertising Samuel Kier's rock oil. The drawings next to the lettering showed derricks used in boring and pumping Kier's salt brine wells—and something clicked in Bissell's mind.

Drill for oil!

**Find the Source.** All that had come so far from the Oil Creek land were the few barrels which had been obtained by trenching the seepages and dipping out the liquid in buckets or wringing it out of saturated blankets. Bissell had long thought that beneath the ground there must be a pool of oil from which this seepage oil was coming; but the big question was how to get it to the surface.

Now, Bissell had the answer—put down a well for the specific purpose of bringing up the oil.

Apparently Bissell's idea didn't set the stockholders on fire however and the project languished until finally the panic of 1857 overwhelmed the partners. There was much bickering and strife among the stockholders and finally a group of New Haven stockholders, led by James M. Townsend, president of the City Savings Bank of New Haven, took control.

Townsend formed the Seneca Oil Co. and leased the land in Pennsylvania from the Pennsylvania Rock Oil Co. of Connecticut. Bissell and Eveleth, for all their troubles, retained only a royalty interest.

**A Man Named Drake.** At the time he formed this new company, Townsend was living in New Haven at the Tontine Hotel. Also living at the Tontine was Edwin L. Drake, 38, a widower of a year, and his small son. Because of illness Drake had left his job as a conductor on the New York & New Haven Railroad.

Townsend knew that Drake was a jack-of-all-trades—but other than that he had no particular qualifications for the job he was given. Drake had grown up on a farm, had worked as a farm laborer, clerk on a Lake Erie passenger boat, hotel clerk, clerk in dry goods stores, railroad express agent, and railroad conductor.

Nevertheless, Drake was made general manager of the newly formed Seneca Oil Co., and was given an annual salary of $1,000. He was also given an additional $1,000 to begin drilling for oil on the Titusville land. Therefore, in May, 1858, Drake accompanied by his son and a newly-acquired wife, moved into Titusville which was, at the time, little more than a struggling lumber town. To give Drake a bit of prestige, Townsend coined the title of "Colonel" and sent several letters ahead addressed to "Colonel" E. L. Drake.

No matter what Drake lacked in experience, he certainly made up for it in determination and finally, in August, the "Colonel" and his right-hand man, Uncle Billy Smith, struck oil—at a depth of 69½ feet. Overnight "Drake's Folly" started a boom that rivaled, and certainly had more reaching consequences than the California gold rush.

At first, the well produced 25 barrels a day, and the oil sold for $18 per barrel—unheard of wealth; and it was just below the ground for those who wanted to reach down and take it.

## Birth of An Industry

AT THE TIME Drake's well came in, there were 53 coal oil refineries operating in the United States. Most of them were operating under a patent held by Dr. James Young, a youthful Scottish chemist who owned a first-class refinery in Scotland which made lubricants and illuminates from shale, peat and coal. His business was extremely profitable, and he guarded his process jealously.

These 53 refiners initially viewed the discovery of oil with no alarm. In their opinion, the pool was strictly local and would quickly exhaust itself. As a matter of fact, when Young himself hurried to America to visit the oil field, his comment was, "I dinna think it will amount to mooch."

To Young's surprise, however, it did "amount to mooch" and it wasn't long before the 53 coal oil refiners realized the era of refining coal was at an end. A few immediately went out of business while others experimented with the new product in their stills. Eventually some came to the conclusion that with some mechanical changes, it would be possible to produce an excellent grade of illuminant and lubricant from the crude petroleum right in their already established plants.

### REFINERIES GROW IN NUMBER

As the refining of oil lagged further behind production, the Seneca Oil Co. decided to go into the refining business. However, internal dissension and bankruptcy soon prevented the company from executing its refining plans.

Soon after the completion of the Drake wells, however, refineries sprang up all along Oil Creek, the Alleghany, at Union Mills Corry, and Erie.

The first real oil refinery in Titusville was built in 1860, by W. H. Abbott, James Parker and William Barnsdall. Most of the machinery and appliances bought in

Pittsburgh had to be shipped by boat up the Alleghany to Oil Creek. Also, the acids which the refinery used were shipped from Cincinnati—an item which made them somewhat expensive by the time they had reached Titusville.

The first run of oil was made on January 22, 1861, at the refinery which consisted of six stills and bleachers, with all the fixtures and tanks under one roof. The yield did not exceed 50 percent of the crude and not knowing how to utilize by-products, the refiners either dumped them into Oil Creek or burned off all tar and naphtha.

**Distillation Reigns.** At this time, distillation was almost the sole activity of the refiner. These early stills, borrowed or taken from the coal oil refiners, were oval or round in shape, generally vertical, of cast iron, bottoms and walls sometimes 6 inches in thickness, capacities of 6 to 60 barrels, with a thermometer and gravity stick the only control instruments available.

In 1862, between Titusville and Oil City, John E. Bruns and the Ludovici brothers of New York City erected what has come to be known as the Humboldt Refinery. This refinery used larger stills of the horizontal type, made of comparatively thin wrought iron plates, although the use of the upright type persisted in some refineries for 20 to 30 years. The Humboldt Refinery covered several acres, employed over 200 men, and was operated more on scientific principles than any other refinery of the time.

**The Downer Plant.** One of the most famous of the early refineries was the plant owned by Samuel D. Downer. At the time he heard of Drake's discovery, Downer started for the oil field in order to find a suitable location for a refinery. In October, 1861, he began clearing away the forest, making bricks, putting up buildings and in less than two years time, he had the largest and finest refinery in operation in the oil region. It cost Downer $125,000 to build the plant but it had a capacity of 400 barrels of oil daily and regularly employed 150 men to operate the works.

There is no doubt that Downer devoted a great deal of time and effort to his plant. He took great care to prevent explosions, and spectators were hardly ever admitted. Near the furnaces there was even an apparatus for throwing steam suddenly into every room with great force in case of fire. A chemist by the name of Joshua Merrill and two Boston chemists, Luther and William Atwood, were responsible for a great many improvements in the refinery processes, and were of valuable assistance to Downer.

By the end of 1860, 15 small refineries dotted the Pennsylvania oil region. Three years later there were 61 refineries, with capacities varying anywhere from 15 to 300 barrels a day.

### TEARING DOWN THE PREJUDICE

Actually, the cost of refining was not great. A shanty, still, worm and all, with a 5 barrel-per-day capacity could be erected in 1860 for about $200. A very efficient refinery could be built for $1,500 and for $4,000 a person could build one which would purify daily more than the richest well could produce in 1860. Taking everything into consideration, the oil could be refined for about 5 or 6 cents per gallon.

It would not be truthful to say, however, that the early refiners found a ready market for all their products. As a matter of fact, they experienced no end of difficulties. Some operated for a period of 14 years under license of the Young patent; others adopted the Downer process; some used the Gsner process and others stumbled along using their own methods. Fires were common and more than one of the early refineries went up into a pillar of black smoke and hungry flame. Bankers were none too kind to those behind the very new industry and financial problems were frequent. Also, a shortage of skilled refinery workers kept many of the plants from carrying out the extension programs they felt justified in planning.

**Accidents Were Many.** To add even more to these refiners' woes, the early lamps which burned the fuel were none too safe. Accidents were frequent; unpleasant fatalities involved women, children and the loss of prop-

## What Happened to "Colonel Edwin L. Drake"?

For Drake, fate reserved the pathetic end which it seems to reserve for so many pioneers. With his well completed, he showed no eagerness to join the oil land scramble and amid mutterings of "inefficiency," his New Haven associates ousted him as president in March, 1860. The Titusville townspeople elected him justice of the peace and, from this position, he derived an annual income of about $3,000. He also acted as purchasing agent for a New York drug house which bought much of the oil for resale to kerosine manufacturers. This netted him an estimated $5,000 a year additional. In 1863, Drake took about $15,000 or $20,000, left the oil regions, went to New York and lost all of his money in a brokerage house in which he became a partner. He returned to Vermont broke, and then developed arthritis which became progressively worse until he was completely crippled. On his doctor's advice, he moved to Chapel Hill, N. J., to be near the sea.[12]

One day in 1869, while he was still able to walk, Drake was in New York and ran into an old friend, Zebulon Martin, proprietor of a Titusville hotel. Martin was shocked to see Drake in the same coat he had worn nine years previously and to learn that he had only 60 cents in his pocket. Martin hurried back to the Oil Regions in the hope of raising a fund from the men who benefited so much from Drake's discovery. There was great talk of building him a fine home and providing him with a trust fund; but, after 15 months, less than $5,000 had been collected. His disappointed friends next proceeded to Harrisburg, where in 1873, they lobbied through the legislature a pension of $1,500 a year for him. Thus, it was as a pensioner of the state of Pennsylvania that Drake died in obscurity in 1880.[9]



OIL CENTENNIAL ISSUE

**By the end of 1863, 61 refineries dotted the Pennsylvania oil region. Here is the Monitor refinery near Oil Creek, Penn.**

erty. Newspapers unfortunately, featured such events and in certain quarters a decided prejudice was formed against use of kerosine as an illuminant.

Indeed, so strong was this prejudice and so lusty the bias, that from 1868 through 1869 the government of the United States stood squarely behind a law that forbade use of petroleum products as illuminants on any vessel or steamer that carried passengers. Certain states also passed laws which prohibited the use of petroleum products as illuminants on passenger trains.

We cannot blame these early legislators for their attitudes, however. More than one serious fire aboard steamer and train was caused by the use of a dangerous and defective lamp in which kerosine was burned. Some of the fires, too, were caused by sheer stupidity of those in charge.

**Better Lamps Too.** The refiners had to tear down this wall of prejudice. They accomplished this largely by supplying a better and cleaner grade of illuminant and by supplying, at a nominal cost, adequate and efficient lamps. When these walls of prejudice crumbled, however, kerosine swept into high public favor. "Signal Oil," another name for kerosine, was used in great quantities by the railroads and was found to be superior to any other oil used.

The lubricating oils never faced any real bias, consequently they were readily marketed and achieved their first fame as railroad lubricants. Quickly, other mechanical phases of industry adopted the new lubricants, and the price of tallow and sperm oil hit bottom with a dull thud.

## Refining Covers a Nation

IN THE MIDDLE 1860s the oil bubble was inflating at an alarming pace. Everyone was interested in oil and anxious to make money quickly. This rush and excitement, was intensified by the Civil War's end, which brought peace and left the country flooded with inflated currency. The capitalists were eager to invest their greenbacks to make more money—and thousands of soldiers constituting a ready supply of labor were discharged from the army and waited to be absorbed into peacetime activities.

It was around this time when a young partner in a mercantile commission house in Cleveland by the name of John D. Rockefeller decided to purchase an interest in a refinery in Cleveland. Having looked over the booming oil region of western Pennsylvania, Rockefeller decided the producing end of the oil industry was no place for an orderly businessman, but he did see a future in refining.

Rockefeller brought his meticulous methods to the refining business and in 1860 he and his associates incorporated their business and the New York business of Wm. Rockefeller into the Standard Oil Company (Ohio).

Convinced that small local firms could not survive in a highly competitive business, Rockefeller and his associates conceived a far-flung combination of commonly-owned firms as the logical pattern for the oil business. Other firms, at first in Cleveland and then elsewhere, joined the alliance over the next decade. It expanded and grew until, by 1880, it included a large segment of the American oil industry.

In January, 1882, this combination became known as the Standard Oil Trust. Ten years later this trust was dissolved in favor of another form of centralized control, and in 1899, Jersey Standard became the central holding company for the entire group. By 1904 the Standard group was marketing 80 percent of U.S. oil products and did 76 percent of the refining business.

In 1911 however, the Supreme Court had the Standard Oil organization dissolved into 34 unrelated companies.

**Chemical Wizard.** In Canada, too, the refining industry was attracting men with notable reputations. One such man was Herman Frasch, who had already made a reputation as a chemical wizard. Now, in the spring of 1884, this short, thick set man with a carefully trimmed Van Dyke beard arrived in London, Ontario, Canada, to apply his talents to Ontario's oil problems.

Ontario oil producers and refiners were faced with a problem of an overpowering odor of sulfur in Canadian crude and kerosine which gave it the name "skunk oil." In less than a year Frasch solved the problem and saved the Canadian oil industry from virtual extinction by placing it on a competitive basis with the sulfur-free oil pouring in from Pennsylvania fields.

Frasch made many contributions to the oil industry. Six years later, in 1890, he launched the American sulfur industry and gave American industrialization another boost. By providing a domestic source of natural sulfur, he made available cheap and adequate supplies of sulfuric acid.

## OIL OUT WEST

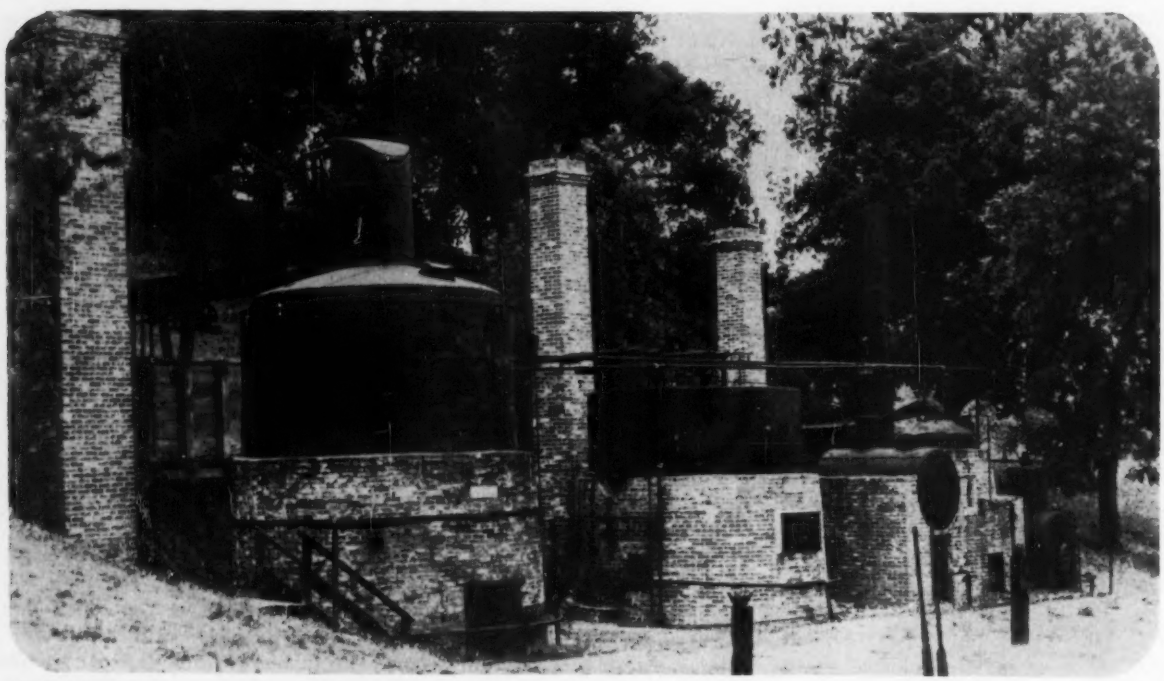
The West Coast came into the picture in the 1870s with the discovery of oil in that area. In 1876 the California Star Oil Works was formed which was a forebearer of the Standard Oil Company of California. The company erected a small refinery at Newhall and another near Ventura and, by 1879, there was enough production to justify laying a 2-inch pipe line from the Pico producing area to the Newhall refinery.

In spite of all this, however, 1878 was a year of near disaster for the West Coast oil industry. Pennsylvania production flooded the East with oil. Prices tumbled and hard times came to the new industry in California. It was largely due to the efforts of two individuals, Charles Felton, banker and former assistant treasurer of the United States in charge of the San Francisco mint and Lloyd Tevis, president of Wells Fargo, that the industry was kept from going under.

In 1879 Pacific Coast Oil Co. was founded on a good, sound financial basis. It had a large scope of operations and among the interests it acquired were the California Star Oil Works and the Pico Well.

In 1880 the company opened a refinery in Alameda, across the bay from San Francisco. The plant had a 500-bpd capacity. The range of products was wide; two grades of kerosine, lubricating oils, machine oils and headlight oil.

**More Problems.** However, the West Coast refiners had their problems. The principle one was refining from asphalt crudes. The market was essentially for kerosine,



**Kerosine and benzene were main products of the early refinery. Here is a restoration of a small refinery once erected at Newhall, Calif., in 1876 by The California Star Oil Works Co.**

but refiners could get only a low-grade product which could be sold only after blending with the eastern kerosine. It became clear, therefore, that if the new industry was to survive on the West Coast, there had to be a broader base for it.

Fortunately for California oil, the coal stratum of the region bordering the Pacific was of relatively minor importance. The coke was low in Btu's, it coked with some difficulty, and was high in ash. As a result of this, gas companies began using oil as a substitute for the costly imported coal, and gradually other industries in the state turned to fuel oil as a basis of their energy. The new market developed and flourished, and fortunately, the cost of West Coast fuel oil was relatively low so fuel oil from other areas could not compete.

As production increased and the new market developed, the western industry became of increasing interest to Standard Oil men in the East. After several attempts to acquire Union Oil Co., Standard Oil finally entered the production and refining picture on the West Coast in 1900, through the purchase of Pacific Coast Oil Co.

## DISCOVERY IN TEXAS

In 1894, when oil was getting to be the king-pin in the East and on the West Coast, it was still a stranger to one section of the country which was later to become the refining center of the world—the Southwest. At Corsicana, Texas, 55 miles south of Dallas, the town council was bothered about water. There wasn't enough of it in thirsty Navarro County so the city fathers checked their resources and summoned the American Well and Prospecting Co. to drill a well and perhaps tap the Artesian water vein deep beneath the surface.

The company set to work and at 1,035 feet the drillers hit their water vein. When it flowed to the surface, however, it was colored brown and had a slight stench. Oil! Not much of it—but a trace.

**The Word Got Around.** Crowds came to look at the stuff and before long a cigar touched off a fire that completely destroyed the derrick. The drilling company, under contract to get drinkable water, fought the seep of oil and finally sealed it off.

But, the news was out. There was oil under Corsicana. One man, Ralph Beaton, and other Corsicanans wanted to find out just exactly how much.

The wells were drilled and, in 1896, production hit 1,450 barrels daily. In 1897 it zoomed to more than 65,000 barrels and in New York, Pittsburgh, London, and all over the world oil men looked at their maps. They didn't know whether this was a flash-in-the-pan or a whole new oil area.

**Refinery Needed.** With all this oil in Corsicana, there had to be a refinery. This started the process which was to eventually result in the first refinery in the Southwest. The mayor of Corsicana wrote a letter to J. S. Cullinan, owner of the Petroleum Iron Works at Washington, Penn., outlining the need for a refinery. Cullinan got to Corsicana in October, 1896. Asked what kind of a deal for crude he could get if he did build a refinery, the townsmen of Corsicana huddled and then offered to sell him 150,000 barrels of crude at 50 cents a barrel if the plant was built.

Cullinan then got together with the Standard Oil family in an attempt to get that organization to do the actual building of the refinery. An agreement was made to form J. S. Cullinan & Co. as an integrated operation, covering producing, refining, pipelining, storage and marketing operations. An up-and-coming man in the Standard organization by the name of Edwy R. Brown, assistant superintendent of the Acme refinery at Olean, N. Y., was chosen to take charge of the Corsicana project.

**Work Starts.** Brown met Cullinan and they began to search for a site for the refinery. They finally settled on a 20-acre tract south of Corsicana about a mile from the producing field. Nearby ran the Houston & Texas Central Railroad—more commonly referred to as the "hen and two chicks." The ground breaking was on June 6, 1898, in 110-degree weather and construction started.

They hauled in flint from a creek bed when they couldn't get gravel for the foundation. But the refinery went up brick on brick, pipe by pipe. Finally the vessels arrived—big horizontal boilers placed over brick furnaces.

Many Corsicanans were hired to work in the refinery but skilled people had to come from the oil regions of Pennsylvania, New York and West Virginia.

So urgent was the demand for the refinery that Brown worriedly studied his construction schedules. He could wait until early 1899 and have the whole plant ready to go or he could hurry along with one or two stills and get that much out of the way.

**Christmas Beginning.** Brown decided to push on with the one or two stills and by Christmas Day, 1898, one was ready. Two New Yorkers showed up that afternoon to run the first crude.

J. S. Cullinan and Co. became Corsicana Refining Co., which later became Navarro Refining Co. Navarro properties were merged with those later built at Beaumont by Security Oil Co. and this combination formed the Magnolia Petroleum Co. Brown became Magnolia's first vice president and general manager and Cullinan its second vice president.

**Boom Days.** Shortly after the turn of the century the oil industry in the Southwest really began to flex its muscles. In fact, it was on January 10, 1901 at 10:30 a.m. that the first great American gusher blew in like a shot from a heavy cannon and spouted oil 100 feet over the top of the derrick. Thus, it was at a small area just outside of Beaumont, Texas, that the world would soon come to know as Spindletop. It took nine days to cap the well which spread the countryside with anywhere from 70,000 to 100,000 barrels of oil per day.

Overnight the town of Beaumont became bedlam. The population doubled and then doubled again. The hotels and boarding houses had men sleeping in relays, 20 to a room. It was not uncommon for speculators to make fortunes and then lose them in the gambling halls that stayed open 24 hours a day. At one point, oil was so

plentiful that it sold for 3 cents a barrel and water so scarce that a barrel brought $6.

With all this oil, it was only natural that petroleum refining would assume a major industrial role in the Southwest. There were, however, some difficulties in that the Spindletop crude contained large quantities of sulfur compounds and the gravity was generally 20° to 24° API. Because of this, one Standard Oil Co. official at that time advised his company that because of these undesirable characteristics, Spindletop would be of little significance in the U.S. oil picture.

Fortunately, however, there were those who did not share this pessimism, and in 1902 the J. M. Guffey Refining Co. had a plant in operation at Port Arthur, Texas. The plant was connected to the Spindletop field by means of a crude pipe line. It was shortly thereafter that Guffey Refining was taken over by Gulf Refining Co.

In that same year, a company which was later to become part of The Texas Co. started constructing a second plant at Port Arthur and the following year, in 1903, the plant went on stream. It is interesting to note that The Texas Co. was founded in 1902 near Spindletop by J. S. Cullinan, the same man who had initiated the building of the refinery at Corsicana several years back.

## The Early Refiners

DURING THESE early days distillation was the most popular refining process. However, one of the earlier cracking processes was apparently carried out in the mid 1860s. This was done on a small industrial scale by distilling heavy oils under pressure of "two atmospheres" in a steel boiler capable of withstanding pressures to "seven atmospheres." This process, patented by James Young in 1865, was later described by him as having been practiced for the production of illuminating oils.

Of course, there is the often-told story of the discovery of cracking by an operator who, when suddenly taken ill, returned to his 16-barrel still after four hours absence to find an abnormally high kerosine yield with production still going on. This was so surprising to the chemist-proprietor that investigation and experimentation led to the general adoption of the practice of allowing heavier vapors to condense and return to the still for cracking, bringing about an increase of at least 20 percent of the principal product of what had so aptly been called the "kerosine age" of the industry.

**Distillation Progress.** Distillation was the refiner's bread and butter and individual refinery operators generally used the batch method. In this method a still was operated as a unit with the products being taken overhead at temperatures varying anywhere from 200 to 1,000 F. There was little, if any, controlled fractionation of overhead products in these operations; therefore the naphtha and distillate fractions had to be rerun in order to achieve the finished gasoline and kerosine cuts.

As the demand for petroleum products increased, the batch operated stills became increasingly inadequate. Consequently, around 1870, refiners were turning their attention to continuous distillation. It is surprising to note that in spite of some successful attempts at continuous distillation abroad, very little was accomplished in this country for a long time. But, finally in 1877, a gentleman by the name of Samuel van Syckel showed the way by continuously operating a battery of steam stills. However, it was in 1885 and later before any general use of the principle was made.

**Use of Stills.** Generally, a number of small refineries were built within the first couple of years that a new field was discovered. Invariably these fields developed rapidly with little regard for conservation principles which are now recognized. As a rule, the first refineries in the Southwest used methods adapted from those refineries which had been operating since Drake's well in other parts of the country. The Cheesebox Still, which was widely used in the East until around 1890, was installed in some of the first plants in the Southwest. The bulk of early distillation, however, was done with shell stills.

In the period shortly before 1900 Cheesebox Stills were gradually superceded by the horizontal shell stills which offered advantages of fuel economy and reduction in other unit cost elements, through the increased scale of operations.

These first shell stills usually had a capacity of anywhere from 200 to 600 bpd although later some were expanded to take as much as 1,000 barrels daily.

## How The 42-Gallon Barrel Came Into Being

In the early frenzied days of the oil business, customers bought petroleum in barrels which they furnished and transported themselves. Prices were set by the barrel—and just about any size and kind of barrel qualified, as long as it was ample enough to suit the buyer yet not too commodious in the eyes of the seller.

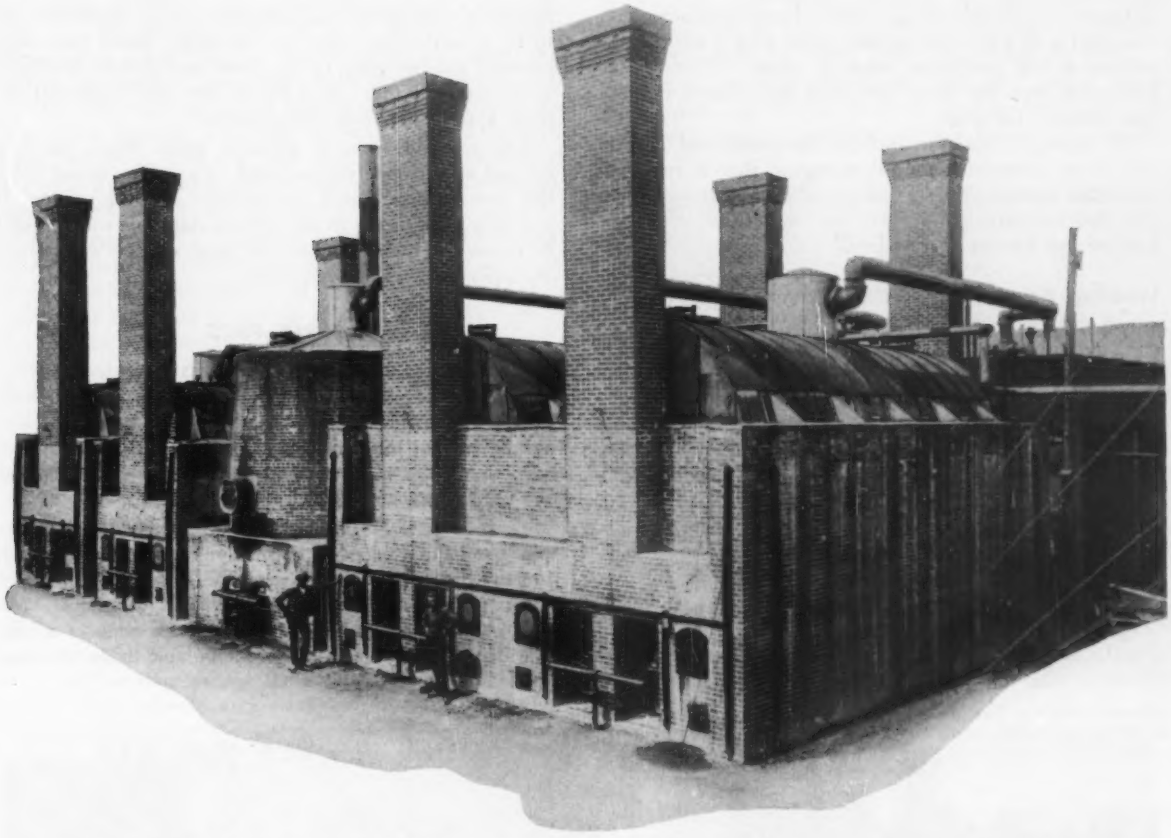
Such an arrangement was bound to cause not only confusion but friction. Tempers quickened as prices rose and fell, and before long it was apparent to everyone that a realistic measure would have to be established and held to.

So in August of 1866, a group of producers got together in West Virginia and issued a proclamation which read, in part: "We must mutually agree that we will sell no crude oil by the barrel or package but by the gallon only. An allowance of two gallons will be made on the gauge of each and every forty gallons in favor of the buyer."

While they specified the gallon as the measure, it was the 42-gallon that gradually emerged, through years of usage, as the common unit.[6]

### THE "BENZINE" SWINDLE

It must be remembered that the first refiners were strictly interested in distilling the kerosine from the crude and were at a loss to know what to do with the residue. As a consequence, they faced quite a disposal problem. One such residue was a fluid that was highly inflammable and



**The Cheesebox Still like this one at Sinclair's Wellsville, N. Y., plant, was considered modern cracking in the early 1900s.**

explosive and was called "benzine." Of course, it was not a welcome by-product because it was so dangerous to handle and difficult to store. Not knowing what to do with it, some of the refiners dumped it into streams, where it promptly killed all the fish. Others poured it into gullies, while some burned it in deep pits.

If there was any use at all in the colorless, gasey-smelling liquid, it was for the washing of greasy overalls. Oilmen soon found that the overalls thickly covered with grease could be washed in the benzine and emerge with almost every spot gone.

It is interesting to note that this benzine formed the basis for a hoax in which the oil producers fooled the refiners for many years.[4] It all started when one such producer noted that the benzine was extremely effective in removing the grease from overalls. He asked a Titusville refiner how much he would charge for a few barrels of benzine and naturally the refiner was delighted to get it off his hands and sold it for 10 cents a barrel. The producer loaded his wagon with seven barrels of the fluid and drove to his oil well.

About this time the producer's oil wells were steadily dropping in production. He knew this was due partly to the oil bearing sands becoming clogged with paraffin, a condition which could only be cured by "shooting" the wells with a heavy charge of explosive—quite an expensive procedure.

**Ups Production.** The producer funneled three barrels of benzine into the tubing of one of his wells—the next morning he started the engine and a thick stream of oil poured into the derrick tank. In one short time the producer watched the level of the oil in his tank rise far above normal production and when he measured the tank he found that the production had substantially increased. As he had suspected, the benzine dissolved the clogging ingredients in the oil sands and rejuvenated the well, making it possible to produce nearly twice as much as it did when it was originally drilled.

There was another cause for elation when he realized that the benzine had also mixed with the oil and had blended it so perfectly that he had almost a complete recovery of what he had poured into the well. It was as if the producer had stumbled onto a money-making machine. It was possible for him to buy benzine at 10 cents a barrel and then sell it, mixed with oil, to the company from which he had purchased it for $3.87 a barrel. At the same time, the stuff increased the flow of oil from the well.

Over a period of years producers bought thousands

of barrels of benzene for 10 cents a barrel and after they had used it as a laxative in their wells, sold it back to the refiners at the prevailing price of crude. However, the producers kept the secret well and the refiners did not hear about it for years.[4]

Of course, it was not until the invention and general use of the internal combustion engine that a real and profitable market for the fluid was found. It was then that benzene emerged into its real sphere of usefulness and became known as "gasoline."

**Whaling Death-Knell.** There was another by-product which plagued refiners and this was somewhat of a greasy residue. At first the refiners tried treating it with acid and filtering it, but later others discovered that when the greasy residue was subjected to intense cold, under pressure, it would produce a fine quality wax. Of course, the wax found a ready market and the residue lubricant was so excellent that it is credited with putting the finishing blows to the whaling industry.

The discovery of this better and much cheaper lubricant came at a most opportune time, for American railroads were on the brink of a great expansion—as was the rest of America.

Of course, the new lubricant was hailed with great joy by all the machine manufacturers and engineers. In fact, it was so good that it meant almost all existing machinery had to be redesigned and most engineering textbooks had to be revised. With this new lubricant, closer tolerances between moving parts of machines and greater speeds of shafts were possible. As a result, new and improved designs appeared almost immediately.[5]

The railroads were a different story. When the first refiners approached the railroads in an effort to sell them this new lubricant, they encountered solid opposition. It was only by agreeing to pay for any damages which might be caused by their product that these refiners were given an opportunity to prove its value.

## EARLY FIRES

Probably one of the greatest threats to early-day refiners was fire. There were no gas storage tanks and tanks were frequently ignited by lightning. The quality of materials was not designed for the conditions under which they were used and safety practices and activities had not yet become prevalent.

There were a great many refinery fires but one of the most spectacular occurred at Titusville on Friday morning, June 11, 1880. During a severe thunderstorm, a flash of lightning struck a storage tank of the Titusville & Tidioute pipe line which was located on the peak of a hill. Immediately a dense cloud of smoke and flame shot upward as 20,000 barrels of oil ignited.

**A severe thunderstorm in 1880 started a number of tank fires which eventually spread to the plant of the Acme Oil Co. The fires lasted for three days and caused such widespread destruction that the company turned its back on Titusville forever.**

Shortly thereafter, two other storage tanks were set afire by the intense heat and each exploded with a tremendous roar. Flaming torrents of oil ran down the hill to the number one plant of the Acme Oil Co. and, as tank after tank exploded, hurling mountains of smoke and flame upward, Titusville appeared to be a doomed city. For three days the fire raged with undiminished fury but miraculously the city was spared and, strangely enough, not a single life was lost.

The Acme Oil Co., however, suffered property damage of more than $275,000. Active operation of the company was never restored, except in a limited measure and finally the company turned its back on Titusville forever by building an extensive plant at Olean, N. Y.

**Titusville Tragedy.** A dozen years later, on June 4, 1892, a worse fire took place which involved both Titusville and Oil City. For several days preceding that day there had been heavy rains in Oil Creek valley. On Saturday morning Oil Creek had risen to the top of its banks and, by midnight, water had flooded many of the streets of Titusville. As a consequence, the city was without water, gas or electricity.

About midnight the large dam at Spartenburg, a few miles above Titusville, gave way and, with a roar like thunder, the mass of water struck Titusville. It came with such suddenness that the people did not have time to reach higher ground and, by 2 a.m., the whole southern portion of the town was under water. Homes floated from their foundations and hundreds of people sought safety on roofs, telephone poles, trees and drifting timbers.

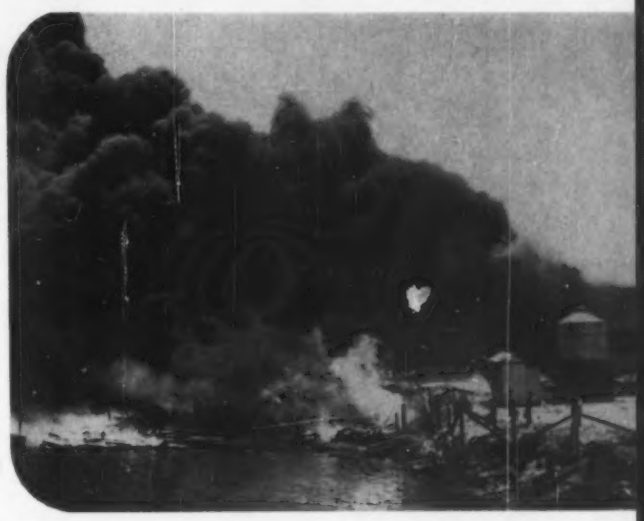
Then, around 3 a.m., fire broke out in the Schwartz refinery with the result that tanks and stills were blown to fragments and streams of burning oil on the surface of the water carried the flames up and down the creek. Oil Creek was a sheet of fire and, as a consequence, there were additional explosions at neighboring refineries. Thousands of panic stricken people fled to the hills as the fire spread.

**Oil City Also.** Meanwhile, at Oil City, citizens had lined the banks of Oil Creek watching the rapidly rising water. But unnoticed by many was a bluish haze which hung over the raging water—it was benzine gas. Suddenly there was a blinding flash and instantly the creek became a mass of flame as billowing clouds of smoke rolled high over the city.

When the destruction was finally over, Titusville counted more than 75 lives lost, hundreds homeless, and property damage of more than $1 million. In Oil City more than 50 persons lost their lives, 800 were left homeless and the property damage was approximately that of Titusville.[6]

By the time we were a few years into the 1900s, most storage tanks were equipped with steam smothering lines. This was on the theory that steam introduced into the upper part of the tank would act as a smothering agent. This worked fairly well in tanks with steel roofs, but in the case of tanks equipped with composition roofs the roof was generally shifted, resulting in an open area which permitted air to enter, thereby supporting combustion and preventing the steam from smothering the fire.

The old practice when tanks were afire was to try to pump out most of the contents and to play water on adjacent tanks to keep them cool. However, with the advent of gas type tanks and the use of foam, tank fires were practically eliminated.



**The modern refinery incorporates a number of safety practices geared to keep down fires such as these. This one started in 1911 with a barge exploding near the Port Arthur docks.**

**Port Arthur Dock Fire.** It was in June, 1911 that a catastrophic fire was just barely averted at Port Arthur, Texas. The Texas Company operated a large case and can making installation as well as a large warehouse near its dock. At that time, most kerosine was shipped in two five-gallon rectangular cans packed in one wooden case or box. Practically all of this went to the Orient, India and Australia while most kerosine was shipped to Europe in tankers. Lube oil was shipped in bulk in tankers or in drums.

Early in the morning of June 26, 1911, the barge "Humble," belonging to The Texas Company exploded at the Port Arthur docks, setting fire to the ship "Dallas," the tug "Brady," the barge "Shenango," and the British steamship "Strombus." The "Humble" and "Brady" were total losses but the other ships were towed out of the fire without much damage.

Also, three warehouses, containing 125,000 cans of kerosine, were a total loss.

Actually, it was only through heroic firefighting efforts and the removal of the "Shenango" from the fire area which saved the day and avoided a catastrophe. The "Dallas" was loaded with 15,000 barrels of crude and asphalt, the "Shenango" with over 20,000 barrels of gasoline and other docks and warehouses of the Kansas City Southern Railroad contained baled cotton.

# King Gasoline

BY THE TIME the twentieth century was ushered in, the petroleum industry was 41 years old and swinging into high gear. There were 45 states in the Union and America was beginning to be conscious of its own greatness and possibilities. It was a time of rapid developments —of new inventions and boundless faith in the future.

It was also the era of the automobile—the horseless carriage as it was called then—and it marked the beginning of a new chapter in the history of refining. The invention and development of a practical automobile was about to create a gigantic market for gasoline—the product which had been discarded as a nuisance in earlier days.

**First Autos.** Actually it was shortly prior to the change of the century that the first stirrings of the automobile were felt in this country. In 1893 two brothers, J. Frank and Charles Duryea of Springfield, Mass., attached an ordinary gasoline engine to a buggy. At that time, the vehicle went almost unnoticed, but in 1895 when the Duryea "motor wagon" won a race sponsored by the *Chicago Times-Herald* to call attention to the graceless state of Chicago roads, it started people talking about the automobile.

Then other backyard tinkers such Charles Brady King, Elwood Haynes, Henry M. Leeland, Alexander Winton, Ransom Eli Olds, and Henry Ford began fiddling with automobiles. The machine shops of Detroit became inventors clubs where in greasy overalls, the founders of an industry exchanged exciting ideas over stripped-down cylinders. Finally a break in tradition came when a New England toolmaker named Leeland introduced standardized, interchangeable parts.

Olds was the first to go in for quantity production and in 1905 he turned out 6,500 of the famous one-cylinder, curved-dash Oldsmobiles. During this time Henry Ford was experimenting with one model after another and finally in 1908 the first Model T "Tin Lizzie" Ford was delivered to dealers.[7]

Probably very few industries have mushroomed like the auto industry. This is exemplified by the fact that in 1896 there were four automobiles in the United States that would run. Two years later there were 800 and by 1911 there were 600,000. Thus the automobile created a demand for motor fuel which gave impetus to the growth of the oil industry.

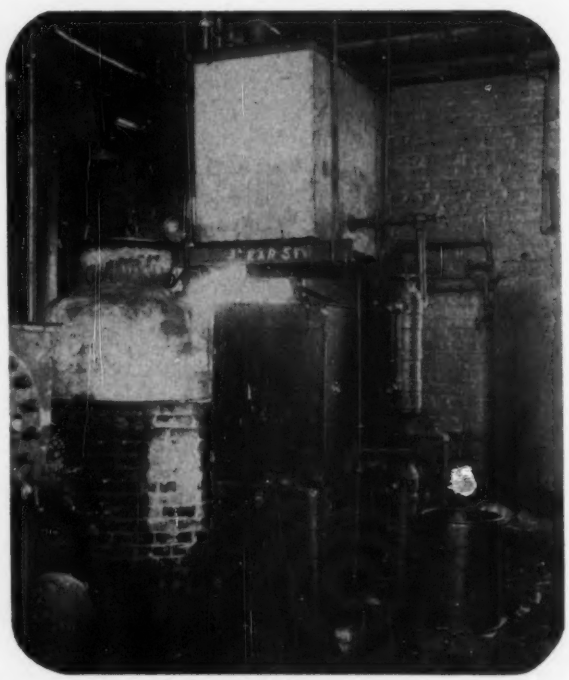
It was also in this general period that another invention was made which would have far-reaching effects on the refining industry. For some time two mechanics had been wrestling with the aerodynamics of wing design. Finally, on a cold, windy beach near Kitty Hawk, N. C., on December 17, 1903, a man in a dark business suit lay flat on his stomach between the wings of a flimsy flying machine. The motor roared, the machine lurched over a crudely made runway, then teetered ten feet into the air. It was back on the ground within 12 seconds and it had only gone 120 feet.[7] But there was no doubt about it—those two mechanics, Wilbur and Orville Wright proved that man could fly, and Kitty Hawk became the Titusville of aviation.

Thus the shift in emphasis from kerosine to gasoline began. Fortunately for the refiner, however, he was still producing enough surplus gasoline so that there was no real need for optional flexibility of gasoline yields. Even as late as 1913 much gasoline was still being marketed in this country as "stove gasoline." It is interesting to note, however, that in 1911 the Standard Group for the first time sold more gasoline than kerosine.

## EARLY CENTURY TECHNOLOGY

Around 1902, technology in the art of distillation finally started showing some improvement. It is most surprising that previously there was a lack of appreciation for the possibilities of selective condensation as an aid in spearation obtained from distillation. Although there were some who had mentioned the suitability of the bubble tower which followed the plan of whiskey rectification, nobody really gave any serious thought to applying this principle to petroleum refining. Even today, there is no adequate explanation for the delay in the adoption of this important fractionation device.

Probably the most noteworthy and most revolutionary step of this era was the tower developed in 1905 by The Atlantic Refining Co. at its Philadelphia plant. This was a combination of a stone filled vertical column with a two-section, air cooled tubular partial condenser, the tubes being somewhat aslant to provide air turbulence on the cooling side and impinging surface for downward



**Cracking processes were devised to increase the yields of gasoline. Here the original Burton-Humphreys experimental still as it looked in 1910, at Indiana Standard's Whiting refinery.**

condensate flow within the tubes. There were three points for withdrawing condensate from the system or returning it to the still for cracking for wax improvement and increased yields of kerosine and naphtha.

The closer control of the fractionation and quality of products obtained from this method was quickly acclaimed, and the equipment was soon in use in a great many refineries.

**Mostly Shell Stills.** In spite of this, however, the principal processing equipment of a 1910 refinery was a battery of horizontal cylindrical shell stills which charged crude oil on a continuous basis. In order to provide for continuous operation, several such shell stills were connected in series with each located at a lower level than the preceding one. The crude oil flowed by gravity feed from one still to the next with fires at progressively higher temperatures under succeeding stills.

Of course, it was impossible to get sharp separations between products at different boiling point ranges. Very often gasoline fractions included some kerosine fractions while kerosine was many times diluted with both gasoline and distillate fuels. Nevertheless, the 1910 refinery was a distinct advancement over the units utilized in the very early days of the industry.

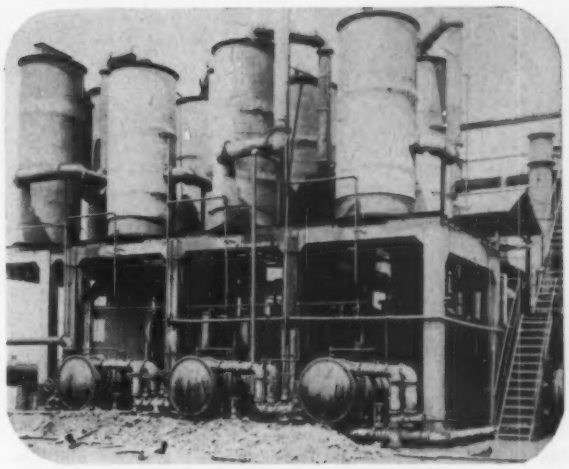
**"Banjo Towers."** Refining techniques got in full swing in 1912 when William Burton announced his new cracking process. Long vapor lines were being used to induce the return flow of unvaporized portions of the liquid to the still. Burton's process added another vapor line to increase the exposed cooling surface, augmented a little later by a small air cooled radiator-type pipe condenser, called from its appearance "the banjo towers."

This was the first real cracking process to be successfully operated primarily to increase gasoline yield. Burton and his associates did this at Indiana Standard's Whiting plant in 1912 and the following year it was installed on a large scale. On March 1, 1913, Indiana Standard announced a new "motor spirit." It cost the consumer three cents a gallon less than straight run gasoline and it was expected that the product might find a market in stationary engines and motor trucks. However, some experienced refiners doubted whether such a product could be marketed.

The first large Burton still was 8 feet in diameter, 20 feet long, and made of ½-inch mild steel plate. This unit operated so successfully that 60 similar units were built. These were heavy riveted shell stills of 200 to 250 bpd capacity. Gas oil, or a similar distillate, was a charging stock used with the oil being heated to 750 F. and the pressure maintained at about 75 psi.

**Not Continuous.** It must be remembered that at this time the cracking process was not continuous with the refining operation. Rather, it was generally carried on as a supplementary processing operation to simple distillation, using one of the straight run products as a charging stock.

The operating cycle was about 48 hours per batch with a yield of around 50 percent. After each cycle, the stills were emptied and cooled sufficiently to allow workmen to enter and scrape the carbon from the bottom. It wasn't until 1914 that somebody got the idea of inserting a false bottom of thin removable steel plates which would be easily removed and cleaned.



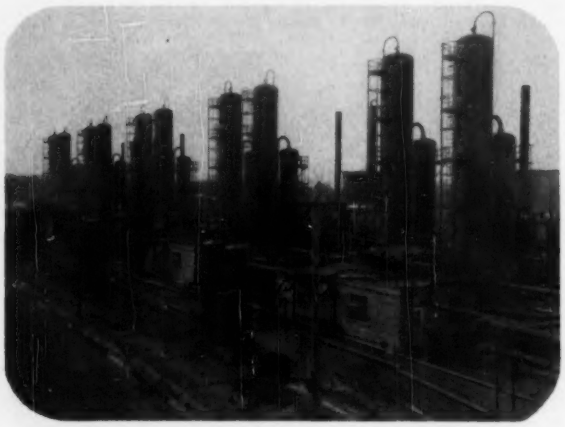
**Partial coolers (dephlegmators) were used in connection with the early crude processing equipment. Shown here are some which were in operation at Shell's Wood River refinery in 1920.**

**Early refiners also improved their processes by experimentation. This 1916 photograph shows the laboratory building of Shell's Martinez refinery plus experimental stills and agitators.**

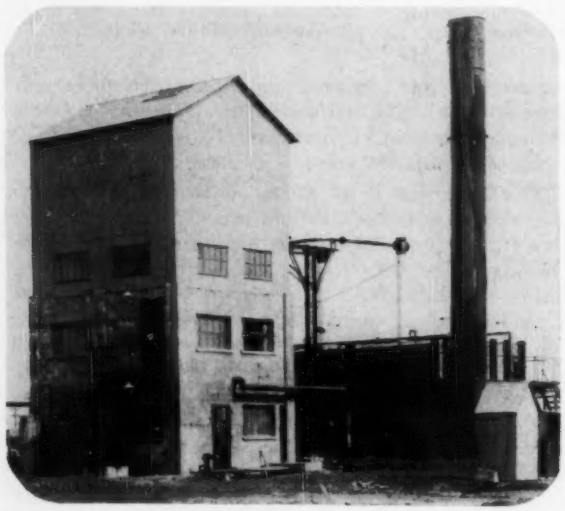
This same year E. M. Clark, an associate of Burton's and vice president of the Standard Oil Company (New Jersey), patented the method for cracking oil in a circulating system, the oil being pumped through a heating coil to a chamber from which vapors were withdrawn to a condenser and residual oil recirculated to the heating coil. In 1921 Clark patented the process of cracking oil in an apparatus resembling a water tube boiler. The process was generally known as the Burton-Clark process and of course used the Burton-Clark tube stills.

With the entry of the United States into World War I, the demand for gasoline skyrocketed, thereby causing the widespread installation of the Burton process in many American refineries. Even as late as 1928 there were 1,200 Burton or Burton-Clark stills in existence, although

The first large commercial Holmes-Manley cracking unit was erected in 1917 by Texaco, at its Port Arthur refinery.



First licensed commercial unit of the Cross still was built in 1920. These 1926 stills were at Magnolia's Beaumont refinery.



The first licensed Dubbs Cracking unit was completed at the Wood River, Ill., refinery of Shell Oil Co., in March, 1921.

by 1930 only 191 units were reported still in operation.

For his great contribution to the refining industry, in May, 1918, Dr. Burton was awarded the Willard Gibbs medal by the Chicago Section of the American Chemical Society. Then, on January 13, 1922, he received the Perkin medal from the American Section of the Society of Chemical Industry.

**Thermal Cracking.** The basic processing equipment of the average refinery in 1915 differed from the 1910 refinery principally through the addition of batch-operated Burton pressure stills. This process was termed "thermal cracking." With the addition of the Burton stills, the 1915 refinery yielded 35 percent more gasoline per barrel of crude oil run than did the plant of 1910.[8] During the 12 years from 1913 to 1925, the Burton process and its improved forms practically monopolized the manufacture of cracked gasoline.

With the advent of thermal cracking, petroleum refining underwent a significant change. The commercialization of thermal cracking was made necessary by the rapidly expanding market for automotive fuels. Had it not been for this cracking, refiners would have had to build up tremendous amounts of unwanted by-products just to satisfy the demand for gasoline by the rapidly expanding automotive population. As a matter of fact, one licensor remarked in a 1924 advertisement of his process, "And the refiner who does not crack his oil is likely to crack his company . . ."

The Rittman cracking process was being perfected by the Bureau of Mines about the same time that Burton cracking was applied. The Tube and Tank process used a modification of existing cracking principles as given in Ellis' patent of 1915. Many other types of cracking units were installed in this period. The Texas Company erected the first large Holmes-Manley unit in 1917. The first licensed commercial unit of the Cross still was installed in 1920. Next year a Dubbs unit was erected. Some of the other cracking processes of this era are Fleming, Greenstreet, Hall, Jenkins, and McAfee, just to name a few.

Probably no other process in the petroleum industry has been subjected to as much debate and questions of patent priority as has cracking. It would be virtually impossible to evaluate the differences between the processes since they have been argued at great length in many cases before the courts. Probably it is misleading that many cracking processes installed by companies bore names implying they had some distinctive principle or novel feature, as in many instances this was not the case. However, to distinguish fairly between all of them would be to assume the functions of the court and anyone who has read the testimony of the cracking patent infringement suits in the U.S. Courts will appreciate this difficulty.

One high spot of the whole cracking patent litigation, however, came during the suit filed in 1916 by Universal Oil Products Co. against Standard of Indiana for infringement of Jesse Dubbs' patent. At that time, UOP's director of research was Dr. Gustav Egloff (known in

the trade as "Gasoline Gus"), who testified for several months late in 1927 and on into 1928 at a hearing in St. Louis. On February 16, 1928 the St. Louis Post Dispatch felt moved to comment editorially:[12]

"We are lost in admiration of Dr. Egloff, oil expert of the Universal Oil Products Co. of Chicago. In the dim, dead days of last November he took the witness stand in a suit of his company against the Standard Oil Co. No matter what the suit is about, Dr. Egloff today is still on the stand and still talking. The workaday world has saluted the Armistice colors, waxed fat on Thanksgiving turkey, dressed a Christmas tree, observed a New Year's faturnalia, and paid court to his lady love on St. Valentine's—and Dr. Egloff is still talking. How does he do it? Well, one day an unwary attorney asked him to define emulsion. Snapping into the subject, Dr. Egloff answered him in seven calendar days of four hours each . . . we repeat, we admire him, but—remembering the seven days answer to the emulsion question—we would never be so incautious, especially if we were in a hurry, to ask him what time it is."

**Another cracking process of this era utilized the Fleming units like these at Continental Oil Co.'s Ponca City refinery.**

## TEL ENTRY

It was during the 1920s that an additive was developed which would give gasoline the ability to resist knocking in engines. The actual research work on such an anti-knock compound had started in the privately owned laboratory of Charles F. Kettering, in Dayton, Ohio, in 1916. Along the way, "Boss Ket" sold his laboratory to General Motors and joined that company. However, it was under his auspices that Thomas Midgley, Jr., headed the research which finally resulted in the discovery of tetraethyllead as an effective anti-knock agent.

The first retail sale of gasoline containing tetraethyllead was on February 2, 1923, at a service station operated by The Refiners Oil Co., at the corner of Main an 6th streets in downtown Dayton, Ohio. Actually, it had been planned to start sales on February 1, but there was some delay in delivering the gasoline to the stations so that the experiment had to be put off until the next day.

As it turned out, this gasoline with the anti-knock quality was an instant success. Before the first day's sales were over, motorists lined up at the station to try the new product.

Cheered by the success of the first day's sales, The Refiners Oil Co. introduced the leaded gasoline a few weeks later at another of its Dayton outlets. Then, by midsummer, motorists could buy the new motor fuel at any of the 75 service stations which The Refiners Oil Co. operated throughout Ohio. The company became the talk of the oil industry.

Before long, however, other refiners, marketers and distributors became interested. Success with experimental sales during the summer of 1923 prompted Standard Oil Company of Indiana to sign the first formal contract for supplies of the tetraethyllead compound from the General Motors Chemical Co., predecessor of Ethyl Corp. It was in September of that same year that Indiana-Standard offered the anti-knock gasoline for sale, thereby becoming the first major retailer of the popular new product.

## GASOLINE—QUALITY AND QUANTITY

It was around 1923 that many refiners began to realize that some yardstick was needed for gaging the quality of gasoline. Some still used gravity as the sole indication of quality, although others wanted some measure as to whether the product was good, clean, "sweet," and free from water.

Distillation test was possibly the one big step in determining the value of gasoline. The test itself was a simple one and proved conclusively the percentage of extremely low boiling hydrocarbons present, as well as the existence of high boiling fractions. Distillation revealed the composition of the gasoline, something that gravity testing did not do, and thus was the logical test to judge gasoline quality.

Another test was to see whether the gasoline was "sweet." Gasoline was termed "sweet" when it would not impart a dark color in the presence of sulfur and a solution composed of litharge and caustic soda. This was known as a "Doctor Test" and a gasoline which failed to pass was called "sour."

Another way to ascertain the quality of the gasoline was to determine its color. Refiners reasoned that the color of good and pure gasoline should be water white and any deviation from this point showed another feature of incomplete refining. Through use of the visible gasoline pump, an off-colored motor fuel detracted from the sale of the product.

It was also around 1923 that the unsaturated hydrocarbons came into prominence in the manufacture of gasoline since pressure stills became so prevalent. However, the presence of these in small quantities did not interfere with the quality of the gasoline and the Bureau of Mines stated then that up to 12 percent of unsaturated

products could be used without causing any motor trouble.[9]

**Too Much.** In mid 1924 refiners were having their troubles with an oversupply of gasoline. In May, 1924, out of 250 refineries in the Mid-Continent section of the United States, 124 were shut down. The combined capacity of those 240 refineries was 752,310 barrels per day but the 116 plants which were running had a daily output of only 403,630 barrels.

Assuming that some of the plants were down for repairs, the fact still remains that more than half of the refineries in the Mid-Continent had to shut down because of excessive amounts of gasoline in storage. This combined with the fact that demand was small, due to a late spring.

In spite of their limited technological know-how and the many setbacks they suffered, however, the refiners of this era never lost their resourceful nature. This is aptly exemplified by a news item reported in the October, 1922 issue of *Refiner and Natural Gasoline Manufacturer* (later changed to PETROLEUM REFINER).

"The purchase of an even dozen of goats with an inexhaustible appetite for tall grass and weeds was made recently by the Panhandle Refining Company from a North Texas farmer, to be used in holding down the cost of keeping its refinery and tank farm reservation cleared of rubbish as well as grass and weeds. The idea was conceived by J. B. Fletcher, crude buyer for the company, who is often spoken of by his co-workers as 'goatherder.' Fletcher is proud of his herd and is already making arrangements to supply other refineries nearby with a herd or two by next spring from the stock of 'kids' that are assured by that time. Preparations are being made to put guards on the tanks and stills if the goats become too frolicsome or forsake their vegetable diet for heavier substances."

## Tailor-Made Technology

It is difficult, if not impossible, to pick one date and say "Here is when modern technology had its birth." Many of the present principles of separation and cracking were practiced on gas, coal distillate and vegetable oils long before anyone thought to apply them to crude petroleum. However, it is generally agreed that after catalysis was introduced, the oil industry donned its seven league boots and really took some giant technological strides.

Of course, the principle of catalysis was not new. Even in the petroleum field it had made a few early entries. One of these was the Gray Clay Treating process which utilized Fuller's earth. This process was first used in the treatment of lube oil stocks, and by the early 1920s, was applied to the treatment of gasoline to remove the unstable constituents. In this respect, it replaced the more universally accepted method of treating gasoline with sulfuric acid.

Then, too, around the beginning of the 1900s, a number of researchers were toying with the idea of using a catalyst to promote cracking. Two early pioneers of this thinking were G. W. Gray of The Texas Company and A. M. McAfee of Gulf Oil Corp., who were using aluminum chloride.

**Houdry's Process.** One really significant development in catalytic cracking took place in the 1920s in France when A. J. Houdry developed a catalytic cracking process suitable for commercial application. His method was to process gas oil in the presence of silica-alumina catalyst and heat to make a high octane gasoline.

It must be said that the oil companies did not exactly leap at the chance to grab Houdry's process. As a matter of fact, when he walked into the offices of Sun Oil Co. in 1933, it was the fifth company he had contacted. Even then, he wasn't sure that Sun engineers would be any more interested than the others.

One reason for the reluctance of any organization to sink a lot of money into the process was that the huge East Texas field was flooding the market with cheap oil. With more gasoline than they could sell, refiners weren't enthusiastic about any process which would make more gasoline.

Another reason was that while the process looked fine in the laboratory, the problems multiplied when it came to setting up a commercial sized plant. One such problem was the regeneration of the catalyst. The reaction of cracking the oil caused the catalyst to become coated with carbon, thereby destroying its effectiveness. In order to clean the catalyst, therefore, it was blown with air which caused spontaneous combustion of the carbon coating. Unfortunately, the combustion produce a very high temperature and a commercial scale plant faced the problem of getting rid of the heat before it ruined the catalyst or the case.

**First Unit.** Evidently, however, Sun engineers looked beyond the difficulties and foresaw a method of oil refining which, if perfected, would give them the jump on other refiners. It took four years to achieve the right combination of operating conditions but finally in 1937 the first full-scale commercial unit was installed. It had a 10,000-bpd capacity and went in at Sun's Marcus Hook refinery.

To achieve continuous operation, various methods were used to carry out the catalytic reaction of gas oil in one vessel and to transfer catalyst to another vessel for regeneration. One such method was to use the catalyst in pellets which were transferred between vessels by buckets and later blown around by air.

There is no doubt that catalytic cracking got a big shot in the arm when a catalyst was developed in the form of a powder so fine that it acted as a fluid when aerated. From then on there were many developments which concentrated on ways to make catalyst and methods to move this catalyst between reactor and regenerator. The process proved so successful that most of the major refiners adopted it to satisfy the gasoline demand of World War II.

**Polymerization Followed.** Refiners soon learned that catalytic cracking produced more gaseous materials than had been produced through the use of thermal crackers. Furthermore, the cat cracking gases contained high concentrations of unsaturated materials. It was only natural,

therefore, for refiners to use these gaseous materials to improve the overall economy of their plants. So they took the next step in making more gasoline, which was the application of polymerization principles.

The year 1936 saw the first announcements of commercial polymerization by catalytic methods. At that time, the formation of licensing companies was announced and results were published dealing with commercial catalytic polymerization operating units. Within a short time, the literature was replete with designs, construction operation and technical information.

Up until World War II, catalytic polymerization gained in popularity as it provided a means for converting gases into gasoline. This not only increased the total gasoline yield from cracking operations, but was in itself a high octane product, valuable for blending purposes.

### HIGH OCTANES FORCE NEW PROCESS

During all this time that the refiner was funneling his technology into making more gasoline, the automobile industry was constantly seeking to increase engine power. One way this was done was by increasing compression ratio of the engine which of course forced the need for higher and higher octanes.

It was in 1930 that the octane number concept was introduced to give motorists some indication of the gasoline quality. A year later The Cooperative Fuel Research Committee released a tentative method for measuring octanes. Thus began a new era in refining: not only did the refiner need to concern himself with higher gasoline yields from a barrel of crude but he also took on worries as to the quality of his product. Catalytic cracking was, then, all the more desirable because it not only produced more gasoline, but furnished higher octanes than thermal methods. This quality drive also set the stage for reforming, alkylation and isomerization to make a strong entry into refining.

Actually, these latter methods were already in existence but they had been developed only to meet specific needs of the industry. Therefore, it must be noted here, that they owe their continued livelihood to the fact that refiners were starting to those higher octanes.

**Reforming.** Catalytic reforming, for example, developed many of its principles from those used around 1926 for processing coal. However, it was not until about 1940 that this process was first commercially introduced when it was used to produce toluene for wartime TNT. This was the start of developments for reforming processes to form aromatics for war needs.

One of these aromatics was benzene, which had previously been supplied almost exclusively by coal processing. This was the start for petroleum to take over as a major producer of benzene.

**Alkylation.** Another process which came into its own during the 1940s and was of particular importance during World War II was alkylation. Alkylate was first produced in 1932 by Ipatieff and Pines through the use of aluminum chloride promoted by hydrochloric acid. However, commercial alkylation of isobutane and olefins was done predominantly with sulfuric acid or hydrofluoric acid catalyst. The sulfuric acid process was developed jointly by Esso Research and Engineering Co.; The British Petroleum Co., Ltd.; Texaco Development Corp., and Shell Development Co. The first commercial plant was installed at the Baytown refinery of Humble Oil & Refining Co. in the fall of 1938.

Other companies participating in the early development of the sulfuric acid process were Union Oil Co. of California; Universal Oil Products Co.; Stratford Engineering Corp.; and The M. W. Kellogg Co. Until the war years the process grew slowly and by 1940, this country only had a 20,000-bpd capacity.

The hydrofluoric acid process was developed jointly by Phillips Petroleum Co. and Universal Oil Products Co. The first commercial plant went on stream in late 1942.[10]

**Needs Rise.** Pushed by the aviation gasoline demands of World War II, alkylation capacity mushroomed from nothing in 1938 to 150,000 bpd by 1946. Between 1939 and 1946, 59 plants were built, of which 27 employed the hydrofluoric acid catalyst. Immediately after the cessation of World War II, the demand for aviation alkylate dropped and, as a consequence, between 1946 and 1951, about half of the plants were shut down and several were dismantled.

When the Korean conflict commenced, this country had only 35 plants producing about 127,000 bpd of alkylate. In order to boost this somewhat meager capacity, the Petroleum Administration for Defense, in 1951, began pushing for additional alkylation capacity. The goal was to obtain 26 additional plants, and construction was encouraged by fast writeoffs and government contract guarantees. Also, rising aviation gasoline demands commanded new interest for alkylation. Therefore, by 1955, alkylation capacity had jumped to 227,000 bpd and 60 plants were operating.

Up until this time most, if not all, of the aviation alkylate had been used in making aviation gasolines. Again, in 1955, however, the rapid use of motor gasoline octanes demanded alkylate to be used to augment reformate to make premium motor fuels.

Since 1955 alkylation capacity in this country has climbed steadily and in mid 1958 production stood at 300,000 bpd. It is estimated that in 1959 capacity will approach 362,000 bpd from over 90 operating plants.

**Isomerization.** Another wartime process brought back into prominence by the struggle for octanes was isomerization. Isomerization was first used by Shell and Standard Oil Co. (Indiana) to make branched chained paraffins for wartime aviation fuel. Now it is seen as a way to upgrade the lighter materials in a gasoline blend.

### OIL IN WAR

On the morning of December 8, 1941, as President Roosevelt stood before a joint session of Congress and spoke of "a day that shall live in infamy," a group of oil men were assembled around a conference table on another side of Washington. Fortunately, it was a group which had been formed six months earlier and which had already worked most of the "bugs" out of its organization.

This organization was something new in Washington as it represented effective teamwork between industry

and government. It had its inception on May 27, 1941, when President Roosevelt appointed Secretary of the Interior Harold L. Ickes as Petroleum Coordinator.

**First Meeting.** As the oil man first met with the new Petroleum Coordinator, they talked warily. They had tangled with Mr. Ickes previously over what government termed "conservative measures" but what some oilmen had thought of as strictly regimentation. Several months later, as one oilman thought back on that meeting, he chuckled, "It may have been my imagination, but I think that as I entered the room, someone frisked me for concealed weapons."

Ickes realized the seriousness of the situation as it faced him, however, as was indicated by his choice of a Deputy Petroleum Coordinator. Instead of staffing his new organization with government career men, lawyers, or politicians, Ickes appointed as his deputy, Ralph K. Davies, then ranking vice president of the Standard Oil Company of California. To Davies, a practical executive with 30 years in the oil business behind him, Ickes delegated authority coequal with his own, agreeing that he should go out and get the best men he could find from the industry.

As the war progressed, the government-industry team functioned easier and smoother. The regional liaison was improved by establishing nationwide coordination between Ickes' and Davies' groups, called the Petroleum Administration for War (PAW) and the Petroleum Industry War Council (PIWC).

**Close Cooperation.** The Petroleum Adminstration for War never had any type of enforcement powers, and as it resulted, it never needed them. At one juncture, the oil companies went deeply into the red through the use of tank cars while PAW hunted for legal means of compensating them. They voluntarily pooled supplies, which meant jeopardizing trade names in which many millions of dollars had been invested. They pooled resources for the common good. They kept tankers operating in spite of the prohibitive wartime cost. They produced wells at an uneconomic rate, overran refineries and pushed trucks until pistons rattled and tires collapsed.[11]

Bruce Brown, one oil man who was on the PAW Committee for High Octane for three years said, "I've seen members throw on the table, without batting an eye, some idea that represented an investment of years of research and millions of dollars to their company. Sometimes one company's idea would be tossed in, poured over by representatives of a half dozen rival companies, and maybe finally given to another to execute, because of geographical considerations or because the other had a free refining unit. And I can truthfully say that in all my time on the committee, I never saw a man favor his own company to the disadvantage of competitors.[11]"

It was a Herculean task which oil men had to accomplish as the armed fores used petroleum products at an amazing rate. For instance, it took 60,000 gallons of gasoline a day to keep a single armored division fighting; large bombing raids over Germany used 10,000 gallons of toluene per minute; the fuel tanks of one battleship required enough oil to heat a home for more than 500 years; and one Navy fighter consumed enough gasoline in an hour to drive from Chicago to Los Angeles.

**A Job Well Done.** Probably no greater tribute was paid to the importance of oil than was offered by Admiral Chester Nimitz. At the beginning of the war he said that winning was a matter of "beans, bullets and oil." By the war's end, he had changed that statement. "Now," he said, "It's oil, bullets, and beans!" The oil industry had accelerated its technology to answer the demands of war.

During the almost four years that America was actively engaged in World War II, refiners built nearly $1 billion worth of new refining facilities in the United States, plus roughly $280 million worth abroad—most of which was financed with oil company money.

America did not fail the oil man; nor did the oil man fail America.

## OTHER PROCESSES

Octanes are not the only yardstick of quality which has continued to foster technological advances since World War II. The search for cleaner, more stable fuels has brought on hydrogen treating in full force. Catalytic reforming has furnished the necessary hydrogen for this treating technique, although in some cases the hydrogen requirements are so high that specific hydrogen producing processes are installed. In just the one year period between the first of 1955 and 1956, hydrogen treating facilities jumped from 117,000 bpd to a total capacity of 433,000 bpd. It is estimated this capacity is now over 1.6 million barrels daily.

Thus the present highly competitive market for motor fuels requires the modern refiner to tailor-make his gasoline to satisfy particular demands of the high compression engine. Some already have expressed the feeling that our technology is so specialized that we may now consider motor fuel as a chemical blend. We no longer think of crude oil in its gross sense, but rather as a mixture of individual chemicals. Now we can look to future developments which will permit us to separate these components more easily and convert them more completely to our requirements.

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# THE NATURAL GASOLINE STORY

**George B. Gibbs and Charles H. Vervalin**
Petroleum Refiner Staff

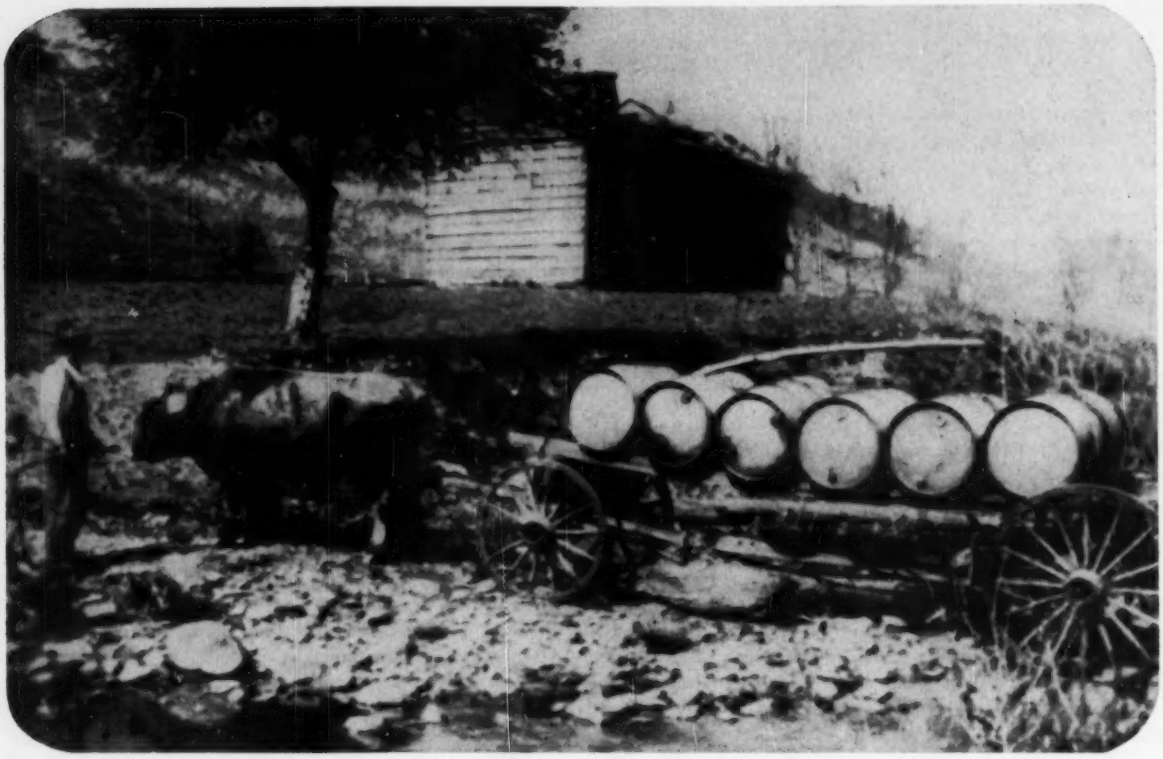
AS SUMMER ENDED in 1903, a Packard completed a 52-day trip from San Francisco to New York City. It was the first auto to drive cross country.

As the year closed, the first successful airplane flight by the Wright brothers was made at Kitty Hawk, N. C. Both of these events were considered spectacular and received wide publicity. It had only been ten years since Charles Duryea completed his horseless carriage. Yet it marked the year that gasoline first started replacing kerosine as the most important oil product.

Unpublicized and not recognized as anything important were the operations by Sutton Bros. and Edwards in Sistersville, W. Va. They owned some oil wells near Sistersville and had laid four miles of pipe to transport gas to a boiler. No sooner had the line been installed than trouble began. They found considerable quantities of gasoline in the sags of the line. They also observed that cooling the gas caused it to condense, so they installed a system of coils in an old boiler and filled it with water. Thus, in 1903, natural gasoline manufacture had begun in the United States.[1]

Perhaps the main reason no publicity was given this event was that drips in gas, having no market or value, were considered quite a nuisance. Also, for some 40 years

**Early plant in Sistersville, W. Va., shows simple equipment used in the compression process.[2]**



**This is Sistersville transportation when plants shipped largely to the refinery at Parkersburg by Ohio River barges (1908). Boom pole binds load; oxen pull load to barge loading point or to blending depot.[5]**

in the vicinity of Tidioute, Penn., gasoline was incidentally produced in gas pumping operations. The gas went through a pump and was discharged against a pressure of five ounces; however, the gasoline collected was not sold nor even saved until 1899.[2]

But if the first plant in Sistersville was accidental and without much import attached, it was only a short 20-year span before the natural gasoline industry grew to more than 1,000 plants, using all the basic processes employed today.

The first natural gasoline (70 degrees Baume) produced by the Sutton Bros. and Edwards was transported in wooden barrels to a nearby refinery for blending. Many problems the first gasoline plant men encountered were those still faced today—(1) getting refiners to buy natural gasoline at a reasonable price and accept its true worth in motor gasoline, (2) developing markets for natural gasoline plants which would make them more independent of refiners, (3) avoiding a seasonal market.

**Early Processes.** The first plants installed to extract gasoline used casinghead gas from oil wells near Tidioute. These wells had declined in production to only a few barrels per day, but gas from the casinghead was very rich in gasoline. Pumps, used to withdraw gas from the wells, delivered gas at only a few pounds pressure; but this was enough to condense gasoline when it passed through water cooled pipe coils. The first operators of these plants were William Fasenmeyer and Thompsett Bros. in 1904.

In 1905 William Mayburg, a retired preacher from New York, bought a gas engine from Bessemer Gas Engine Co. When Bessemer inquired how it was to be used, they found that Mayburg was compressing casinghead gas to about 60 psi to extract the gasoline content. Thus Mayburg's plant can be considered the forerunner of compression plants. The equipment used was simple, consisting of a gas compressor, a prime mover to run it and cooling coils in a tank to collect condensate.

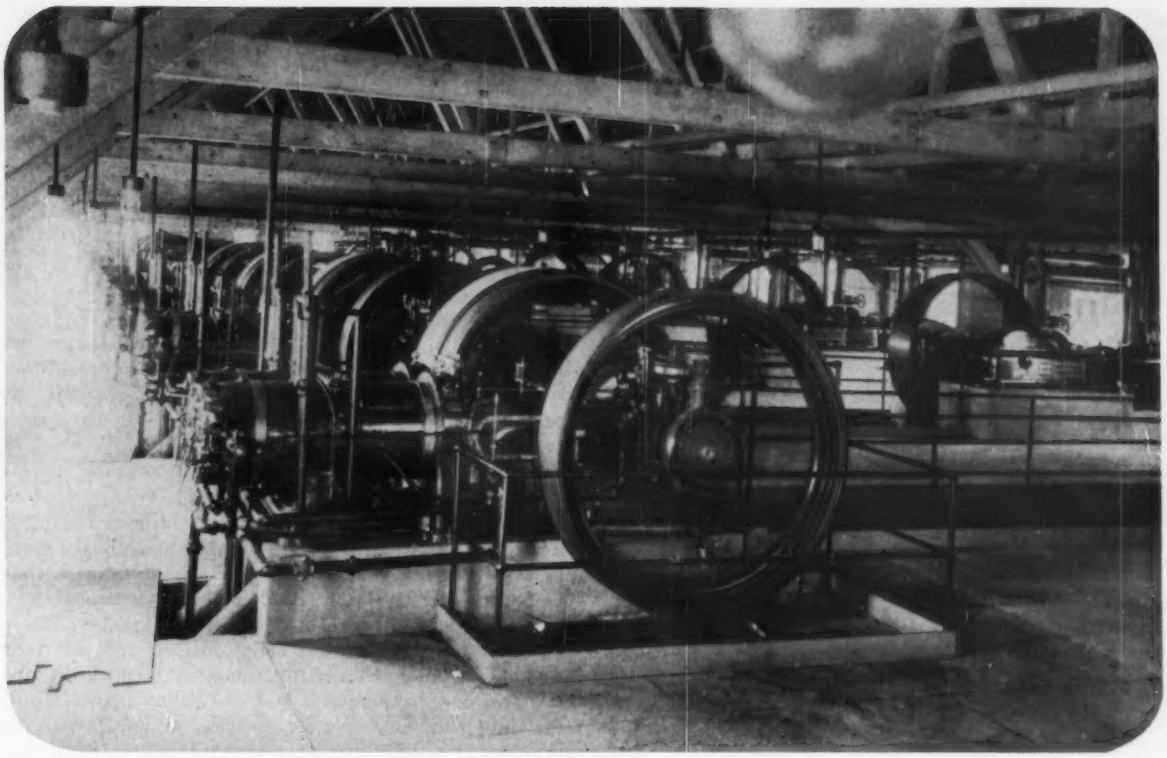
Bessemer Co. quickly realized the potential of natural gasoline. Frank Peterson, who joined the firm in 1910, has been called the father of the natural gasoline and LPG industry,[3] as he devoted exclusive attention to its formation.

The Mayburg plant was quickly followed by Reno Oil Co., which had already installed gas pumps to extract gasoline, and then built in West Virginia in 1908 what is considered the first successful compression plant.

The period up to 1911 can be considered the natural gasoline industry's formative period. It ushered in the commercialization period, 1911-1920.

## COMMERCIALIZATION 1911-1920

Compression plants multiplied rapidly and by 1912 there were 250, most of which used two stages of compression. In 1916 there were 550 plants, and 863 by 1921.



**Show place was this engine room of the Gypsy plant in Glenn Pool (Oklahoma, 1913) and represents the high water mark of the compression process technically. This plant attracted many visitors and used expanders to reduce gas temperature.[8]**

Belt driven compressors were used at first, followed by direct drives.

Quite early, the so-called expansion engine was developed to reduce gas temperatures by expanding the gas from a steam-engine cylinder. Gas at a temperature as low as —70 F. was used to cool the hot compressed casinghead gas as it came from the compressor and through the cooling coils. Such an engine was first installed in 1912. The Gypsy Gasoline Co. (forerunner of Gulf Oil Corp.) installed the first expansion engine in the Mid-Continent field in 1913.

It was realized that there was no need to compress gas to high pressures if refrigeration was used. One of the earliest refrigeration plants was the ammonia type plant installed for cooling gas by the Olympic Gas Co. of Fullerton, Calif., in 1913. Then, four years later in 1917, an attempt was made to use cold brine from an ammonia refrigeration set up for direct contact with compressed gas in a baffled absorber. This did not work successfully and was quickly abandoned.

**Absorption Process.** It was discovered that lean or dry natural gases would not yield much gasoline by the compression method. Gas well gas was not seriously considered for extracting natural gasoline so there was a ready market for the absorption process. The first work in this area was carried out by Hope Natural Gas Co., a subsidiary of Standard Oil Co. (New Jersey), then Stand-

## *In 1911, Texas had no natural gasoline plants*

**(Production of Gasoline From Natural Gas in the United States in 1911, by States)**

| State[2] | Number of Operators | Plants | | Gasoline Produced | | | Gas Used | | Average Yield in Gasoline Gallons |
|---|---|---|---|---|---|---|---|---|---|
| | | Number | Daily Capacity Gallons | Quantity Gallons | Value | Value Per Gallon Cents | Estimated Quantity Cubic Feet | Value | |
| West Virginia | 46 | 71 | 16,694 | 3,615,251 | $258,619 | 7.15 | 1,237,928,600 | $ 74,876 | 2.92 |
| Ohio | 27 | 40 | 6,579 | 1,723,899 | 122,203 | 7.09 | 484,644,000 | 38,772 | 3.56 |
| Pennsylvania | 43 | 50 | 5,669 | 1,467,043 | 109,649 | 7.47 | 526,152,663 | 52,615 | 2.79 |
| Oklahoma | 8 | 8 | 4,800 | 388,058 | 20,975 | 5.40 | 144,629,000 | 4,378 | 2.68 |
| California, Colorado, Illinois, New York | 7 | 7 | 3,358 | 231,588 | 20,258 | 8.75 | 82,343,000 | 6,320 | 2.81 |
| Total | 131 | 176 | 37,100 | 7,425,839 | 531,704 | 7.16 | 2,475,697,263 | 176,961 | 3.00 |

ard Oil Co. At Hastings, W. Va., the company built a plant to treat 150 MMcf of natural gas daily. This plant started in 1913 and used horizontal tanks partially filled with mineral seal oil (a gas oil or topped crude fraction).

The actual development work which led to this plant was started in 1906 by George Saybolt, a chemist with Standard Oil. Patents were issued in 1911 by the U.S. Patent Department and in 1917 Hope Natural Gas (a Standard subsidiary) sued the Oklahoma Natural Gas Co. for building and operating a plant which infringed on the Hope patent. Other independent oil and gas companies joined Oklahoma Natural Gas in defending the suit.

The defendents alleged that the oil absorption process had been practiced in much the same principle for 50 years. For example, the process had been used in England to extract gasoline from gases produced from refining shale oil. It had also been widely used in Europe to extract benzene and toluene from coal gas. There was a like installation for this purpose in the United States in 1898.

The defendents won the suit but the final appeal was not settled until 1922. This litigation caused the absorption process to be held up from 1917-1922.

Actually, quite a few oil absorption plants were built under royalty arrangements with Hope Natural Gas, and some were built without regard to the patent.

During its first few years, the absorption process was reserved for extracting gasoline from high pressure dry gas. Most operators felt it could not be adapted to casinghead gas because of the initial low pressures. However, there was a low pressure oil absorption plant built in 1913 by National Products Co. in the Cleveland Oil Pool, Okla. Five MMcf of gas was the charge capacity and the pressure was not more than 10 psi. The plant production was 1,000 gallons per day.

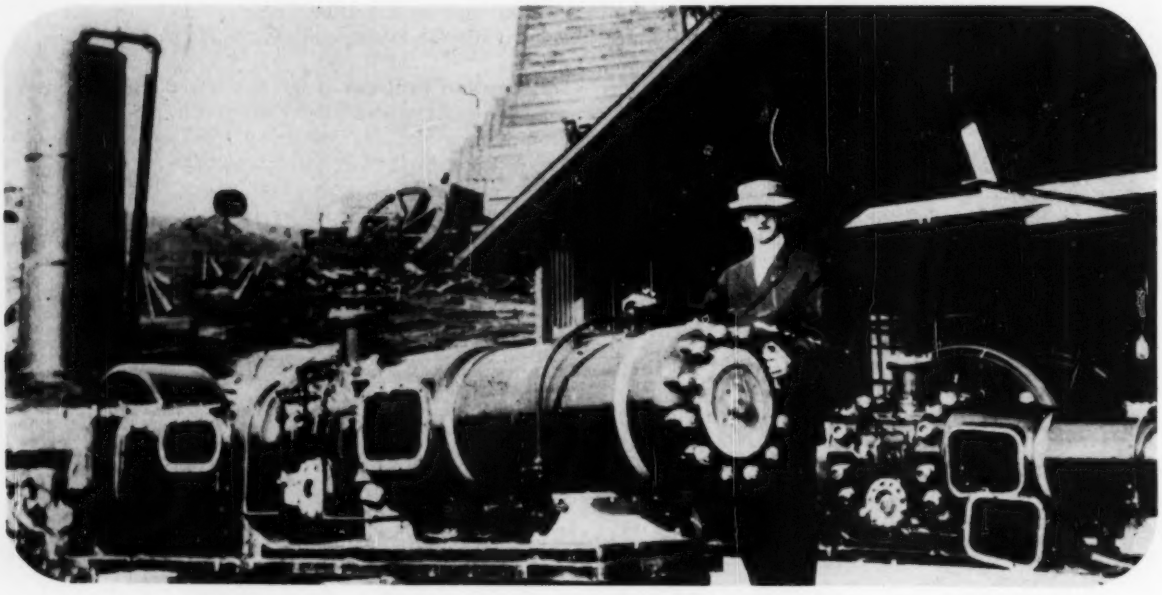
Soon absorption was combined with compression, either before or after. Because it was more stable in character, absorption gasoline demanded a price of one-fourth to one cent more per gallon.

**Charcoal Process.** The charcoal process of extracting gasoline from natural gas was initiated by George A. Burrell and G. G. Oberfell in 1918. A long series of experiments were made at the Bradford, Penn., gasoline extraction plants owned by United Natural Gas. Co. There was a working agreement between that company and Gasoline Recovery Co., which owned the Burrell-Oberfell charcoal process. Later, United Gas built three charcoal absorption plants at Shinglehouse, Roystone, and Van, Pa. At that time the charcoal process was considered an *absorption* phenomenon instead of *adsorption*.

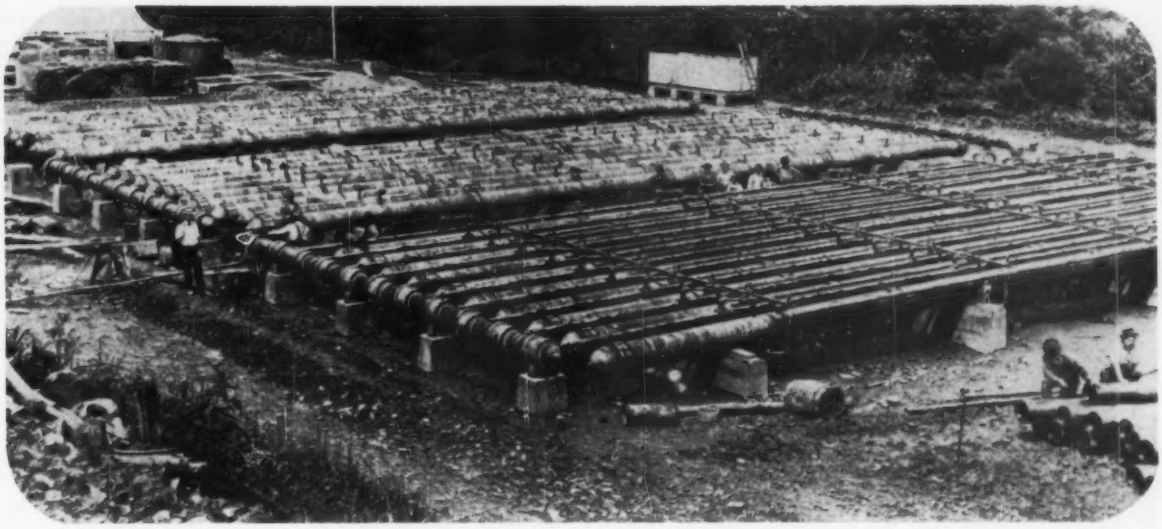
In its simplicity, the process consisted of passing natural gas into adsorbers containing porous charcoal ground to an 8 to 14 mesh. When the charcoal had been saturated, live steam was passed into the adsorber to distill the gasoline. The gasoline and steam were passed through condensers where they were condensed and separated.

Three adsorbers were used in a cyclic manner. While one adsorbed, another was being distilled and the third was being cooled. Charcoal plants were used on the discharge gas of compression and absorption plants. Thus, the three main processes for the gasoline industry—compression, absorption and adsorption—had been developed by 1918.

**Colorful Figure.** One of the most colorful figures of that day was D. W. Franchot, who headed D. W. Franchot Co. and installed a plant in the old Glenn Pool field at Keefer, Okla. This plant used a two stage com-



**This straight line compressor was installed in Pacific Gasoline Company's plant at Brea, Calif., about 1910.[8]**



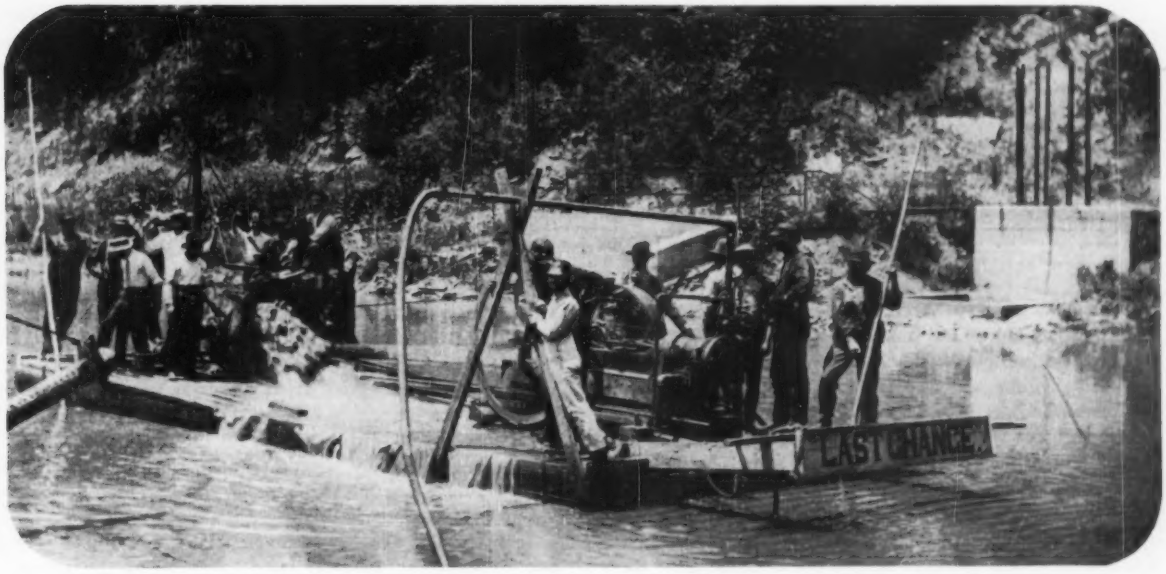
**These were absorbers at the first absorption plant operated by Hope Gas Company at Hastings, W. Va. Operated in parallel, this mass of pipe was equivalent to about one actual plate. This plant sowed the seed that spread absorption.[3]**

pressor with inner cooling. It was belt-driven and Franchot, at the time, gave this reason for a belt-driven compressor:

"The reason that a belt-driven compressor is essential is to separate the gas engine from the compressor, because when this gas is compressed to an extremely high pressure it is as dangerous as the highest known explosive. Also, the compressor should be equipped with a double stuffing box connected to a vent through the roof so that in the event that packing in the gland becomes defective, the gas fumes can be carried off into the air."[4]

Franchot also painted a very bright picture for the natural gasoline industry, and labeled the gasoline market a mint. He further said, "the cost of operating a plant should not exceed, including everything, $15 a day, and a plant capable of making 700 gallons of gasoline per day can be installed for $10,000 complete; and, since there is a ready market for gasoline at 10 cents per gallon, it is easy to see there is a tremendous profit in sight."[4]

**Early-Day Problems.** In this period, some natural gasoline was handled and moved in its raw state, without too much regard to its volatility and inflammability. But most




**To clean the coils, a steam pump on the shaft, with steam from ashore, supplied a water jet that stirred up the silt.[5]**

of the natural gasoline was blended or weathered prior to being shipped to the refiner.

Some operators chose to market gasoline themselves rather than sell to refiners. They would mix natural gasoline with the refinery gasoline or naphtha. A few went so far as to try to sell the raw natural gasoline, and others attempted to pawn off kerosine blends to the public. Even with blending, the gasoline was frequently unsuitable for engines in the summer. The upshot was that natural gasoline got a very bad name.

**Reluctant Refiners.** Until 1920 it was referred to under various names—casinghead gasoline, natural gas gasoline and liquefied petroleum gas. Many refiners were very reluctant to accept it for blending and Standard Oil campaigned against it until 1918.

Blending operation during this period was accomplished by forcing naphtha into condenser coils of the gasoline plant so that the gasoline, as it condensed from the natural gas, mixed with the naphtha. This method was called "hot blending" and was first practiced by B. Stroud and Henry Gulick at a small test plant in southern Ohio in 1911.

When the plant man chose not to blend his own gasoline, he would usually let it weather or evaporate in an open tank until the vapor pressure was low enough for shipment to a refinery or central blending station. Even at this time, some gasoline was pumped into a crude oil pipe line where it mixed with the oil and entered the refinery to be distilled with straight run gasoline. California operators were the first to ship natural gasoline this way.

**High Naphtha.** The refiner was able to keep the natural gasoline man in his place by pegging the price of naphtha higher than natural gasoline. The only place the natural gasoline man could get naphtha for blending was from the refiner.

There were no tests at that time to determine the quality of natural gasoline. About the only two properties measured at a plant were the yield of the product and its gravity by Baume. Most natural gasoline plants were in the hands of independent operators, as the large companies took little interest in the product.

These operators were not always careful. It was not unusual for a drum of natural gasoline to come into a blending station with such high vapor pressure that when the bung was unscrewed, the entire contents of the container blew out into the air.

**Ardmore Explosion.** Accidents became common around plants and at shipping points. One of the worst incidents occurred on September 27, 1915 when a tank car of casinghead gasoline caused an explosion on a railroad siding at Ardmore, Okla. It was thought that the gasoline heated by the summer sun gave off a great deal of vapor which spread along the ground around the railroad track and was ignited from some unknown source. Forty-three people were killed and 500 injured.

But, before this incident, the Bureau for the Safe Transportation of Explosives (under the American Railroad Association) and the Inspection Bureau for the Interstate Commerce Commission became very concerned with this new industry because of railroad shipment. They set up rules and regulations covering shipments. Colonel B. W. Dunn of the Bureau was a leading figure in fixing these rules, and it was he who first called the producers together in 1911.

The first organization of producers was formed to promote the natural gasoline industry. Meeting in Pittsburgh, the group was called Gasoline Producers Association. The president and secretary were S. G. Messer, Tyler Oil Co., Sistersville, W. Va., and Edward B. Rich, Parkersburg, W. Va.

One of the first things they did was to pass a resolution calling on railroads to accept the blended product in tank cars when it did not exceed 76 gravity Baume. The Pennsylvania Railroad had refused to accept straight natural gasoline as well as blended product.

**Standard Cuts.** Interplay between the independents and Standard Oil was also in evidence. News had just been given that Standard Oil, a large purchaser of natural gasoline, had cut the price of it $.015, bringing it down to $.065 a gallon. No explanation of the cut was given until one Standard Oil man who hung around the outskirts of the meeting began bragging to some of the producers what a "good friend Standard Oil was to the trade."

"Yes, we should say you are, cutting the price this morning $.015!" came back one of the producers.

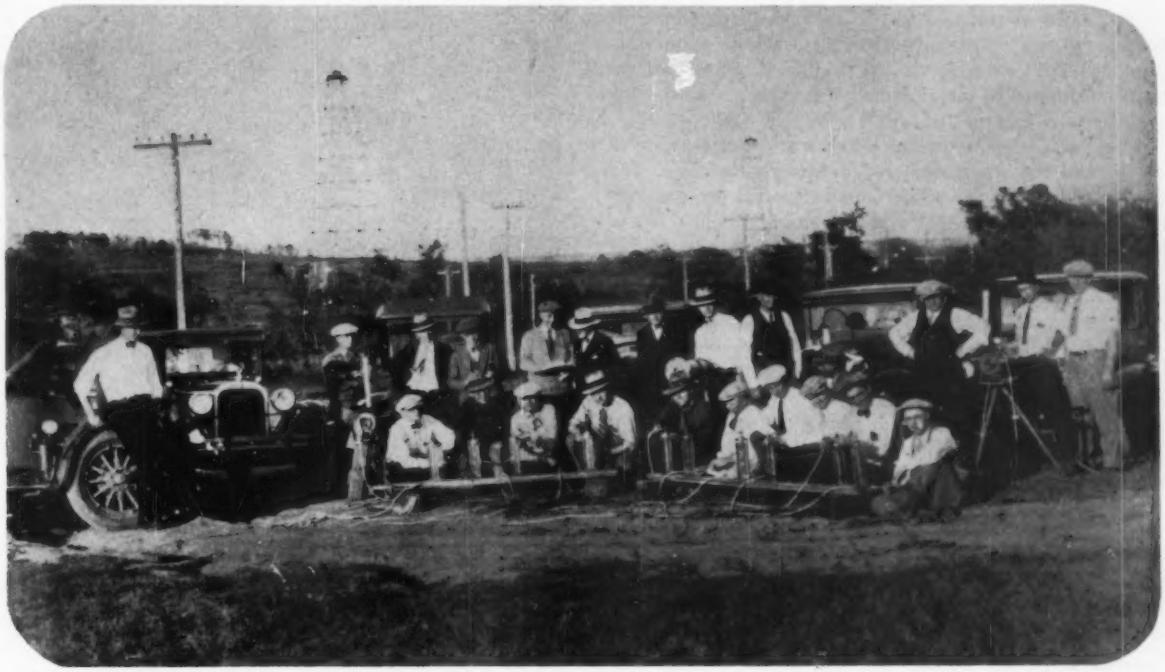
"Oh well, we were just following the lead of the independent refiners on that," replied the Standard Oil man.

"Of course," answered the producer in sarcasm, "I've always noticed the way Standard Oil runs around meekly following the lead of the independent refiners, but they (the independents) didn't cut the price."[5]

But the main purpose of the meeting was to discuss regulations for transporting natural gasoline. At the time the federal law governing transportation of commodities provided for a $2,000 fine and 18 months in prison in case of explosion, and ten years in prison in case of loss of life.

**Natural Not Safe.** The relation of refinery gasoline and natural gasoline was not then known. Some industry leaders felt that refinery gasoline and blended natural gasoline were the same but they were not at all sure. Thus, regulations on tank cars had to be restudied in light of natural gasoline. Since tank cars were, at that time, tested at 40 to 60 pounds pressure, and had safety valves set from 8 to 12 pounds, natural gasoline was not safe for transportation in tank cars unless blended. They were not sure, for example, if a natural gasoline product weathered to 83 degrees Baume was as safe as a refinery gasoline of 84 degrees Baume. What producers wanted was a regulation setting a limit on the gravity they could ship. However, they didn't want it labeled differently from refinery gasoline because of the bad name natural gasoline had at that time.

It was then agreed that wild natural gasoline could not be safely shipped in tank cars. When the product was blended with heavy grades of naphtha, a blended



**In Osage Territory (1926), gas testers gather to run a common test on the same gas. Each has his own gravity bottle, the term given to the Bunsen effusiometer. All testers had slide rules; some wore leather scabbards on their belts to carry the rules.**

product with a Baume gravity no higher than 76 could be handled safely in tank cars. Shipments of the unblended product could be sent in good steel barrels of 55 gallon capacity, when the shipment had been given what was termed the "weathering treatment."

**Inconclusive Test.** Following up on this meeting, Frank Peterson collected samples from refineries and weathered natural gasoline from gasoline plants. He had them compared on the basis of gravity and vapor pressure. These tests showed that gravity did not correlate well with vapor pressure, and that gravity was an inconclusive test for determining shipping regulations. The tests also showed that some natural gasolines were equal to refinery gasolines in vapor pressure. But the most producers could ask was equal shipping restrictions with refineries on whatever basis of danger factor was involved.

Following these tests, the gasoline producers, along with Colonel Dunn, perfected an apparatus to measure the vapor pressure (called vapor tension then).

The ICC ruled that liquefied petroleum gas, which is the name ICC gave natural gasoline, could be handled in tank cars when, at 100 F., vapor tension did not exceed 10 psi, whether blended or not. The same applied to refinery gasoline.

It was required that the product be labeled "liquefied petroleum gas" in any shipping container used. This, of course, was opposed by producers. They wanted to call it just gasoline so the public would not remember the stigma of the past.

**LPG Market.** At the second meeting of the Gasoline Producers Association, Dr. I. C. Allen, in charge of the Pittsburgh laboratory of the Bureau of Mines, asked producers to develop a market of their own for liquefied petroleum gas as we now define it. He said that LPG had been satisfactorily used in burners at the Bureau of Mines as well as in lamps and the oxo-gas welding process. Also, LPG could be shipped in individual cylinders to any place, and by merely turning on the cock there would be a supply of gas. He contended gasoline plant products should be treated as a gas and not an oil.

LPG was then made in the form of compressed gas by cracking oil and used as an illuminant (Pintsch Gas). It was made in liquid form by liquefying cracked gas oil (Blau Gas). Very little came from extraction or liquefaction of casinghead gasoline.

Actually, LPG had been reported in England in 1887 and Pintsch Gas was patented in 1904. Liquefied petroleum gas was first produced in the United States at Happy Hollow Plant, Sistersville, W. Va., in 1910. Frank Peterson, along with Kerr, Burrell and Snelling, conducted many experiments in the 1910-1911 period. As a publicity stunt in 1912, Peterson drove an automobile over the streets of New York City, its fuel a combination of butane and propane.

On October 3, 1911, Colonel Dunn submitted some amendments to shipping regulations that he had previously drafted, and which had been accepted by the Commission. One amendment struck out all the old references to natural gas gasoline and liquefied petroleum gas and inserted the following:

"Liquefied petroleum gas is a condensate from the casinghead gas of petroleum oil wells whose vapor tension at 100 F. exceeds ten psi. Liquefied petroleum gas must be shipped in metal drums or barrels . . . or in tank cars specially constructed . . ."

These amendments meant that natural gas gasoline of 10 psi and less was considered as straight gasoline; and they would apply the name liquefied petroleum gas only to that above 10 psi. Natural gas gasoline below would thus go on the petroleum list. This put natural gasoline on the same basis as refined gasoline.

The next step was design of a tank car which would be approved by the Master Car Builders Association.

Specifications were set up by the MCB Association for a special tank car to ship high vapor-pressure natural gas gasoline. The special cars were to be of heavier structure since the tank would have to stand the cold water test of 100 psi (compared with 60 psi required of the ordinary tank car). The safety valve was to be set at 20 pounds instead of the usual eight pounds. On refinery naphtha tanks the setting was advanced from 8 to 10 pounds. The important feature of the tank was that it be enclosed with a thickness of two inches of 85 percent magnesium carbonate and protected by one-eighth inch sheet-iron jacket.

**Contracts.** In this period, contracts between lease owners and plant operators were simple. The owner was usually paid $5 to $10 per well, plus one half the price of gasoline per Mcf. Thus, if natural gasoline was selling for $.07 per gallon, $.035 per Mcf was paid to the owner.

Relations between royalty owners and lease owners were not quite so simple, however. Most producers paid nothing to the royalty owner except royalty on oil produced. But in 1912, when a producer paid one-eighth royalty on the natural gasoline produced, the royalty owner sued for gas rental payment of $200 per well. Courts in West Virginia decided in favor of the producer, stating the oil royalty clause applied to casinghead extraction and not the gas clause.

Even so, the value of gas for the domestic fuel market was appreciated by many producers and plant owners. Some plant owners in this period, while building new plants on new gas leases, were burning natural gasoline from other plants in earthen dikes, as no market existed for the gasoline. They did this to retain gas leases.

World War I produced a strong demand for natural gasoline. Grade A natural in Oklahoma brought $.24 per gallon. Even as this natural moved into the 1920 post war era, it commanded a price range of $.18-$.21.

## MATURITY 1921-1930

The Commercialization Period, lasting up to 1920 was followed by what might be called the Golden Years.

In the early 1920s there was much debate on the merits of the absorption plant versus the compression plant (or a combination of both). This debate soon decided in favor of the absorption process, which could count more plants in 1924 than the compression process. In 1922 the compression plant could be built for $20,000, while an absorption plant sometimes cost one-fourth as much.

**Bureau of Mines developed this gas balance for measurement, based on the Cardan suspension principle.**

Perhaps the biggest development for the natural gasoline industry in this period was the formation of an association to attack what was truly a big problem then—specification of product quality. The Association of Casinghead Gasoline Manufacturers was organized on April 21, 1921. Shortly thereafter, the name was changed to the Association of Natural Gasoline Manufacturers. In 1926, after dissolution of the Natural Gas Association of America, the present name, Natural Gasoline Association of America was adopted.

The change in name from casinghead gasoline to natural gasoline involved a more accurate description of the natural gasoline plant's product. Thus, casinghead gasoline did not include gasoline made from gas wells. Also, the plant man was trying to live down the bad reputation which casinghead gasoline had in the early days because of its wild and unspecified nature.

**Many Grades.** In the Mid-Continent at the time of the formation of what is now the NGAA, a survey revealed that more than 100 different grades of raw casinghead gasoline blends were being manufactured. This was an impossible situation and the Association went to work immediately to unsnarl the tangled mess of products. The first officers were W. M. Welch, Tidewater Associated Oil Co., president; J. C. Smith, Gilliland Oil Co., vice-president; H. H. Goddard, Chestnut & Smith Corp., treasurer, and A. V. Bourque, secretary.

At the same time the natural gasoline man saw a business publication devoted to his specialized interest—the *Refiner and Natural Gas Manufacturer* (now PETROLEUM REFINER) founded in September, 1922.

**George Bunn (Hanlon Award winner) fills the Woolaroc with natural gasoline. This plane flew to Honolulu in 1927 on fuel made from natural gasoline. This stunt made the headlines that were expected.**

Many of the developments of this period faded out later and are now returning to use. A good example of this is the "jitney" plant, now called a portable plant, which came on the market early in 1923. It was a $5,000 unit, designed for wellhead application for gasoline extraction from natural gas. Occupying an area about the size of a tool shed, all equipment was portable except the condenser. One of the first installed was on a Santa Fe Springs lease in California.

**Fluctuating Market.** Weathering was still a big problem in this early 1921 period. A. V. Bourque, secretary of NGAA said, "Weathering is a continual process. In the summer we weather the product, in the winter we weather the storm." Here he had reference also to the marketing situation which had its ups and downs in this early period, 1921 being a particularly depressive year for natural gasoline.

However, in 1925 a shortage of gasoline appeared and it was very fortunate that the development of the stabilizer should come into being at this time. One of the first stabilizers installed was put in the Burkburnett Field by Tidal Refining Co. It had been developed by Debrey with the Shell group and was covered by patents in the period of 1918-1924.

At an NGAA meeting in 1923, Rafferty of Carbide & Carbon Chemical Co. presented a paper on the stabilizer. Litigation followed and both patents were cancelled. After this, the big development in stabilizers began. Heretofore, there was no precise method for stabilizing natural gasoline. With development of the stabilizer and specifications issued by NGAA, most refiners converted both publicly and privately to the blending of natural gasoline.

**Fuel Research.** Another significant event in this era was the hiring of Dr. George Granger Brown, Department of Chemical Engineering, University of Michigan, as a director of the research program which was carried out in cooperation with the University of Michigan. The objective of this project was to determine the minimum volatility of motor fuels which would give satisfactory performance in the cars of 1926 to 1928. Coupled with this aim, however, was an educational campaign broadly emphasizing the valuable characteristics of natural gasoline as a blending agent in motor fuels.

Much more attention in this period was given to the efficient operation of plants. Safety had become an important part of the plant's program. Pacific Gasoline Co., for example, gave oral tests to employes to improve safety. Shutdown was emphasized. This program included 24 plants and was given to 300 men every three months.

Much attention at this time was turned to methods of distillation and absorption from a more scientific viewpoint. There were no equilibrium K's available and much column design was done by experimenting on the plant itself. In the words of one designer: "Figure them out scientifically and mathematically and then double everything."

Packed towers had long been in use but packing material varied greatly, using everything from pebbles to Ford parts, glass balls, tin cans, bricks and crocks. Perforated plates were also common with holes varying in diameter from one-fourth to four inches. In this period the bubble cap column in many variations was borrowed from the refining industry (which had picked it up from the alcohol industry).

**CNGA Forms.** This was also the heyday of natural gasoline in California, and the time when California became the second largest producer of natural gasoline. There was a significant difference in the California natural gasoline industry, as there is today. For one thing, there were few independent gasoline plant operators, and there was much more integration of natural gasoline into the refinery picture. Thus, unlike the Mid-Continent, where natural gasoline was commonly moved to jobbers or marketed in a blend by the plant operator, in California it was tied up in a network of pipe lines leading to refineries. In 1925 the California Natural Gasoline Association was formed.

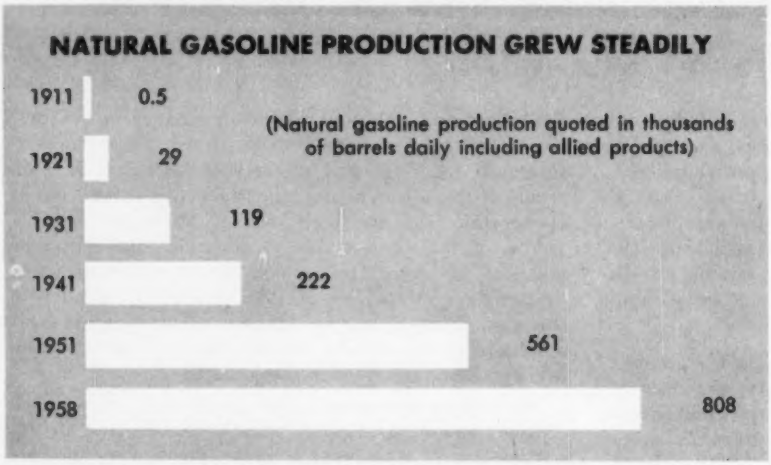
With development of the stabilizer there was now a big incentive toward operating plants at higher pressures. Until 1928 pressures had been at a high of around 300 psi but that year near Monroe, La., the Magenta plant of Natural Gas & Fuel Corp., operated at 600 psi.

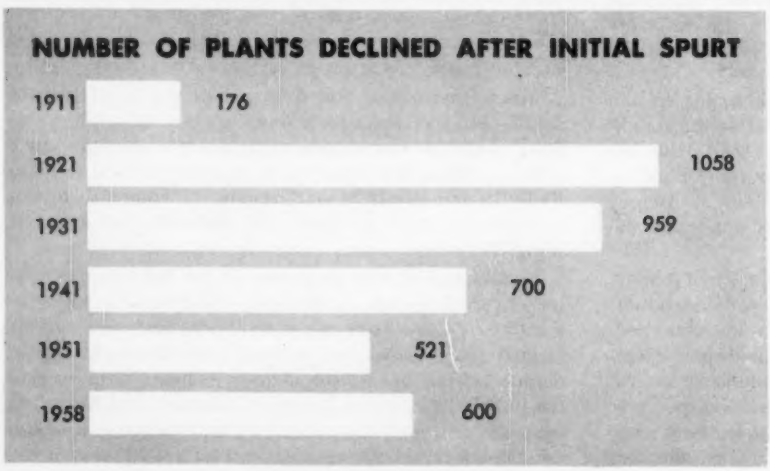
The stabilizer also gave LPG a push. Marketed production jumped from 222,641 gallons in 1922 to 9,925,698 gallons in 1929. At this point LPG was recognized as the fastest growing industry in the United States.[3]

There were also significant developments in the analysis of natural gasoline. The Reid vapor-pressure method was accepted by the NGAA in 1928. This was a much more accurate method than a vapor tension test previously developed. Unlike the vapor tension test, which used only one chamber, this method used two chambers and made corrections for the water vapor and air content in the bomb. Also, at this time, commercial low temperature fractional distillation apparatus was developed by Walter Podbielniak.

Hydrogen sulfide was removed from natural gas in Chatham, Ontario by Union Natural Gas Co.—another first for this era.

Gas was also stored in depleted oil reservoirs. Examples of this were in Coalinga and Buena Vista Hills, Calif. As this "golden era" came to a close, the natural gasoline man found himself heavily dependent on the refiner. Prices had dropped from a high of $.24 in 1918 to a rather stable $.07. A lot of the secrecy about plant operations had faded both in natural gasoline plants and refineries, and the API was able to survey refineries to get their thruputs. It was thought this would be a significant step in marketing, as plant operations and thruputs could be used as a statistical measure for marketing activities.




## DEPRESSION 1931-1940

The beginning of the depression '30s was characterized by the consolidation of many gains made in the 1920s. Octane number had become an important quality of motor gasoline, though natural gasoline operators did not push this point much with their own gasoline. In 1931, after the use of many different engines and many operating conditions for testing octane, a standard engine and octane scale was adopted. Volatility was worked much better in the new specifications adopted by NGAA. This new grading system (much like today's) made use of the Reid vapor pressure and the ASTM percent evaporated at 140 F. The old system made use of gravity and distillation loss. During 1937, NGAA and WPRA sponsored the Pawhuska Road Tests to determine:

1. Limits of road test procedures
2. Permissible vapor pressures
3. Fuel system characteristics of 1937 cars

Though the depression had started in 1929, its impressions were not to be felt until 1931. Gasoline dropped to $.02 a gallon in 1932 and to as low as $.01 in 1933. Oil production started in a big way in the Texas Panhandle and East Texas fields in the early 1930s. The petroleum code for the petroleum industry was issued by the NRA in 1932 but had only an indirect effect on the natural gasoline industry. The code sought to put a floor on crude

prices and to prorate crude oil production. Many of the code's provisions did not stand up in court, however, and most people's concern was whether or not the federal government should get any control over the petroleum industry.

In East Texas, oil proration meant that some wells produced for only 15 to 30 minutes per day. So, a definite time schedule among producing wells had to be achieved to give an even flow of gas to plants.

Until this time many operators worked a 7-day week, 12 hours per day. With the code and blessing of the industry, this was shortened to a 40-hour week.

**Cracking Worries.** The natural gasoline plant man still faced the perennial problem of how to get the refiner to buy more natural gasoline. On the other hand, refiners continued to add more cracking capacity. They felt that could solve front end volatility very well by the way they operated their cracking units.

While the natural gasoline man was worried about cracking, he was also concerned with the refiner's poly-

## *What profits and costs were like in 1926*

**Statement No. 1**

**PETROLEUM PRODUCTION CORPORATION**
**STATEMENT OF PROFIT AND LOSS FOR YEAR 1926**

**Plant No. 9**

| | Gallons | Price | Amount | Amount |
|---|---|---|---|---|
| Sales | 6,845,312 | .10 | | $684,531.20 |
| **Cost of Gasoline Sold:** | | | | |
| Inventory, January 1, 1926 | 365,429 | .0841 | $ 30,732.58 | |
| Gasoline and Naphtha Purchased | 1,884 | .09 | 169.56 | ..... |
| Cost of Gasoline manufactured (see Statement No. 2) | 6,619,233 | .0851 | 563,296.73 | ..... |
| | 6,986,546 | | $594,198.87 | |
| Less: Inventory Dec. 31, 1926 | 141,234 | .0851 | 12,019.01 | ..... |
| Cost of Gasoline Sold | 6,845,312 | | | $582,179.86 |
| Gross Profit on Gasoline Sold | | | | $102,351.34 |
| **Marketing Expense:** | | | | |
| Tank Car Rentals | | | $ 25,507.66 | ..... |
| Office Salaries | | | 5,010.20 | ..... |
| Office Expense | | | 2,289.80 | ..... |
| Advertising | | | 1,000.00 | ..... |
| Discount Allowed | | | 5,761.26 | ..... |
| Outages and Allowances | | | 3,833.26 | ..... |
| Traveling Expense | | | 503.20 | ..... |
| General Office Overhead | | | 330.80 | ..... |
| Miscellaneous | | | 416.00 | ..... |
| Total Marketing Expense | | | | 46,652.18 |
| Net Profit from Operations | | | | $ 55,699.16 |
| Other Income | | | | 1,843.61 |
| Net Profit for Year 1926 | | | | $ 57,542.77 |

**Statement No. 2**

**PETROLEUM PRODUCTION CORPORATION**
**STATEMENT OF MANUFACTURING COST FOR YEAR 1926**

**Cost of Gasoline Manufactured**

| | M. Cu. Ft. | Amount | Cost Per Gallon |
|---|---|---|---|
| Gas Purchased | 4,563,541 | $228,177.05 | $ .03447 |
| Less: Residue Gas Sold | ..... | 76,058.68 | .01149 |
| Gas Used | ..... | $152,118.37 | $ .02298 |
| Absorption Medium | ..... | 4,841.80 | .00073 |
| Operating Labor | ..... | 48,250.80 | .00729 |
| Special Labor | ..... | 24,820.60 | .00375 |
| Repairs | ..... | 40,124.00 | .00606 |
| Supplies | ..... | 32,875.46 | .00497 |
| Fuel | ..... | 12,804.56 | .00193 |
| Water | ..... | 14,670.10 | .00221 |
| Lubricating Oil | ..... | 1,314.01 | .00020 |
| Treating | ..... | 10,624.00 | .00160 |
| Electric Power | ..... | 10,118.87 | .00153 |
| Taxes | ..... | 6,120.00 | .00093 |
| Insurance | ..... | 3,086.71 | .00047 |
| Automobile Expense | ..... | 10,056.81 | .00152 |
| Office and Laboratory Expense | ..... | 26,012.14 | .00393 |
| Depreciation | ..... | 132,384.66 | .02000 |
| General Office Overhead | ..... | 2,456.72 | .00037 |
| Miscellaneous | ..... | 30,617.12 | .00463 |
| | Gallons | | |
| Total | 6,619,233 | $563,296.73 | $ .08510 |

**Statement No. 3**

**PETROLEUM PRODUCTION CORPORATION**
**SUMMARY STATEMENT OF SALES, GROSS AND NET PROFIT FOR YEAR 1926**

| Plant | Sales | Cost of Gasoline Sold | Gross Profit | Marketing Expense | Net Profit | Gallons Sold | Net Profit Per Gallon |
|---|---|---|---|---|---|---|---|
| 1 | $ 351,123.45 | $ 239,969.10 | $ 120,154.35 | $ 23,557.91 | $ 96,596.44 | 3,418,697 | $ .02825 |
| 2 | 41,984.73 | 51,440.31 | 9,455.58 | 1,134.21 | 10,589.79 | 401,239 | .02639 |
| 3 | 1,102,456.31 | 712,124.62 | 390,331.69 | 80,946.21 | 309,385.48 | 12,391,264 | .02497 |
| 4 | 513,782.39 | 360,012.17 | 153,770.22 | 50,126.91 | 103,643.31 | 6,195,132 | .01673 |
| 5 | 204,866.99 | 200,833.38 | 4,033.61 | 16,319.21 | 12,285.60 | 2,260,634 | .00543 |
| 6 | 36,661.78 | 31,102.31 | 5,559.47 | 2,001.32 | 3,558.15 | 420,958 | .00845 |
| 7 | 210,319.62 | 140,693.17 | 69,626.45 | 17,612.39 | 52,014.06 | 2,912,369 | .01786 |
| 8 | 100,093.21 | 81,332.42 | 18,700.79 | 10,598.24 | 8,102.55 | 1,012,369 | .00800 |
| 9 | 684,531.20 | 582,179.86 | 102,351.34 | 46,652.18 | 55,699.16 | 6,845,312 | .00814 |
| 10 | 178,392.41 | 79,451.23 | 96,931.18 | 10,681.24 | 88,249.94 | 2,112,369 | .04177 |
| Total | $3,424,212.09 | $2,470,208.57 | $ 954,003.52 | $ 259,629.82 | $ 694,373.70 | 37,970,343 | ..... |

**AVERAGE SELLING PRICE, COST, AND NET PROFIT PER GALLON OF GASOLINE SOLD**

| Plant | Sales | Cost of Gasoline Sold | Gross Profit | Marketing Expense | Net Profit | Gallons Sold | Total Net Profit |
|---|---|---|---|---|---|---|---|
| 1 | $ .10271 | $ .06756 | $ .03515 | $ .00690 | $ .02825 | 3,418,697 | $ 96,596.44 |
| 2 | .10464 | .12820 | .02356 | .00283 | .02639 | 401,239 | 10,589.79 |
| 3 | .08897 | .05747 | .03150 | .00653 | .02497 | 12,391,264 | 309,385.48 |
| 4 | .08293 | .05811 | .02482 | .00309 | .01673 | 6,195,132 | 103,643.31 |
| 5 | .09062 | .08884 | .00178 | .00721 | .00543 | 2,260,634 | 12,285.60 |
| 6 | .08709 | .07388 | .01321 | .00476 | .00845 | 420,958 | 3,558.15 |
| 7 | .07222 | .04831 | .02391 | .00605 | .01786 | 2,912,369 | 52,014.06 |
| 8 | .09887 | .08040 | .01847 | .01047 | .00800 | 1,012,369 | 8,102.55 |
| 9 | .10000 | .08505 | .01495 | .00681 | .00814 | 6,845,312 | 55,699.16 |
| 10 | .08445 | .03762 | .04683 | .00506 | .04177 | 2,112,369 | 88,249.94 |
| Average | $ .09018 | $ .06506 | $ .02512 | $ .00684 | $ .01829 | | |

merization process. There was some question as to whether polymer gasoline, with its high volatility, might replace natural gasoline altogether.

Studies showed that five-sixths of the volatility in refinery gasoline was obtained from natural gasoline in 1927. By 1935 this had dropped to one-fourth.

Natural gasoline did have octane and a good lead susceptibility to offer the refiner, but it still involved seasonal marketing. The refiner bought gasoline when he needed it for seasonal blending and cut it off later when he didn't.

This was also a period when the number of plants operating in the United States began to drop sharply. Actually the decline started before the depression because of field depletion. During the 1920s investors often asked "In how many months will it pay out?" Now the question was "Do you think the plant will ever pay out?" Many plants were built with used equipment purchased outright or transferred from a plant to be shut down.

Calcium chloride was first used for dehydrating natural gas by Panhandle Eastern Pipeline Co. in 1936. It was placed in the absorber's top section, where the residue gas left.

**Recycling.** One of the brightest spots in the depression era was the development of cycling plants. Until this time, little was understood about the reservoir conditions of what we now call distillate or gas condensate wells. Dr. W. N. Lacey[6] was one of the first to suggest that oil production from a distillate well existed as a vapor in the reservoir. Thus the way was open to explain retrograde condensation—the appearance of liquid condensate after pressure reduction.

For many years the oil industry had recycled gas to producing formations which could be classified as distillate wells—for example, the first wells discovered at Kettleman Hills. However, these were not recognized as distillate wells and there was no attempt to keep a high back pressure on the reservoir in order to maximize liquid production.

The first recycling plant in South Texas was operated by Process Oil Co. in 1937, in the Agua Dulce field, mostly for experimental purposes. The plant was a simple high pressure separator, taking gas from one well and recycling it through another. In 1939 it was followed by the Agua Dulce Gasoline Co. in the same field and the Corpus Christi Corp. in the Stratton field.

The first refrigeration type cycling plant was installed by Tidewater Associated Oil Co. and Seaboard Oil Co. at the Cayuga Field, Anderson County, Texas, in 1938.

The absorption process was not used with first cycling plants because most extraction was based on retrograde condensation. Also, it was believed from initial tests that absorption oil losses would be very high above 100 psi operating pressure.

The first Hanlon Award by the NGAA went to R. C. Alden, Phillips Petroleum Co. (See table.)

In 1937, direct fired heat was used on absorber bottoms, but in the still some stripping steam was still used.

**During World War II, it took 60,000 gallons of gasoline a day to keep one armored division fighting.**

## WAR YEARS 1941-1946

If the depression years seemed to retard the natural gasoline industry, the ensuing 1940s were to see a resurging demand for its products, and much expansion in cycling plants.

Beginning with World War II in December, 1941, the natural gasoline plant began to gear itself for wartime production. This change was mostly in butane production for alkylation (for av gas), butadiene (for synthetic rubber) and LPG.

Plants were concerned mostly with security, government interference, using second-hand equipment (as new equipment was hard to get), long hours and women workers. The question was whether or not alkylation should be installed in natural gasoline plants—also, whether isomerization should be installed there. Actually, nothing during the entire war period was ever done on this score.

Cycling plants became a very important way to increase production. By the end of 1944, production of cycling plants in Texas and Louisiana accounted for 60 percent of total natural gasoline production in these two states. Cycling plants were heralded as an important contribution to the war effort because they required only 28 percent as much steel as oilfield equipment for equivalent crude oil production. It was visualized that in the postwar period cycling plants would compete with refineries by making a finished gasoline, even though it was recognized that marketing by the plant would be one of its problems. The advantages cited for cycling, besides the low investment cost, ($500 per barrel) were: less manpower, no transportation of raw materials, lower operating expense, and less personnel per barrel. All of these were considered advantages over the refiner.

**High Production.** By the end of 1944, production of natural gasoline and allied products was 229 percent of prewar level, or 320,000 bpd. All of this expansion took place without any financial aid from the government. And, though the picture looked rosy at this point, spokes-

## HANLON AWARDS

### High Honor For Natural Gasoline Men

| YEAR | TO | FOR | THEN | NOW |
|---|---|---|---|---|
| 1937 | R. C. ALDEN | Research | Director of Research Phillips Petroleum Co. | Retired |
| 1938 | J. W. COWLES | Gas Contracting | Shell Oil Co. | Retired |
| 1939 | G. G. OBERFELL | Outstanding Contributions | Vice President Phillips Petroleum Co. | Retired |
| 1940 | GEORGE G. BROWN | Research | Professor, U. of Michigan | Deceased |
| 1941 | ALOIS KREMSER | Absorption Mathematics | Asst. Manager Research Standard Oil of Calif. | Retired |
| 1942 | E. O. BENNETT | Pressure Maintenance & Repressuring | Chief Petroleum Engineer Continental Oil Co. | Retired |
| 1943 | F. P. PETERSON | LPG Pioneering | Mid-Continent Petroleum Co. | Retired |
| 1944 | M. H. KOTZEBUE | High Pressure Absorption | President Gasoline Plant Construction Co. | President, Gasoline Plant Construction Co. |
| 1945 | JAMES E. PEW | Wartime Coordination | Director, Natural Gas Natural Gas Div., Pet. Adm. War | Deceased |
| 1946 | W. N. LACEY | Thermodynamic Properties | Professor, California Institute of Technology | Professor, California Institute of Technology |
| 1947 | WILLIAM K. WARREN | Broadening Markets | President Warren Petroleum Corp. | Board Chairman, Warren Petroleum Corp. |
| 1948 | GEORGE A. BURRELL | Natural Gas Analysis | President, Atlantic States Gas Co. | Retired |
| 1949 | FRANCIS E. RICE | Superfractionation | Vice President Phillips Petroleum Co. | Retired |
| 1950 | DONALD L. KATZ | Phase Equilibrium | Professor, U. of Michigan | Professor, U. of Michigan |
| 1951 | WALTER S. PODBIELNIAK | Analytical Apparatus | President, Podbielniak, Inc. | President, Podbielniak, Inc. |
| 1952 | THEODORE L. LEGATSKI | Light Hydrocarbon Research | Ass't. Director Research Phillips Petroleum Co. | Ass't. Director Research Phillips Petroleum Co. |
| 1953 | DARST E. BUCHANAN | Market Expansion | President, Hiwan Oil & Gas Co. | President, Heckethorne Manufacturing Co. |
| 1954 | GEORGE P. BUNN | Outstanding Contributions | Manager, Gasoline Department Phillips Petroleum Co. | Retired |
| 1955 | HENRY N. WADE | Plant Design | Process Consultant Stearns-Roger Mfg. Co. | Process Consultant Stearns-Roger Mfg. Co. |
| 1956 | W. H. VAUGHN | High-Pressure Technology | Manager, Gas Utilization Dept., Tidewater Oil Co. | Manager, Gas Utilization Dept. Tidewater Oil Co. |
| 1957 | CHARLES E. WEBBER | Industry-Government Relations | Technical Advisor to Vice President Sun Oil Co. | Technical Advisor to Vice President Sun Oil Co. |
| 1958 | CLARE D. GARD | Process & Engineering | Retired, Union Oil of Calif. | Retired |

men for the industry warned gasoline plant operators that the postwar era would be a rough one unless cheap processes were invented.

As the war ended in 1945, instead of a big letdown in plant operation, plants immediately began to expand. Perhaps the dominating thing in the postwar era was the development of LPG and, consequently, increased recoveries of propane and butane in the natural gasoline plant. At the end of the war it was felt that this would be an excellent opportunity for plants to completely revamp, because at no other time in history did the industry have the opportunity to replace such obsolete equipment.

D. P. Barnard, Standard Oil Co. (Indiana) suggested that the time was ripe for automobile and plant people to decide if gasoline front end volatility should be increased for conservation and better performance. He also felt that this was an optimum time because so much obsolete equipment would be eliminated. At the same time, he sounded the note that a study like this might show that more butane could not be used by the refiner.

### POST WAR 1947—

LPG did indeed continue its outstanding gain. By the beginning of 1947 production was 13 times larger than it had been in 1937. This tremendous gain had been made despite wartime shortage of steel which curtailed the domestic fuel market for LPG.

In 1948 it became clear that the main product of the natural gasoline plant would be LPG, not natural gasoline. As a result of this, every effort in process schemes was devoted to the increase in LPG recovery. This took several forms, and developments were made in rich oil deethanization, two stage rich oil stripping at high and low pressure, rich oil desorption, lean oil presaturation, and low temperature absorption.

**Air Cooling.** Because of the water shortage in many plant locations, the reduction of water and steam use in design became very significant. One of the leaders in this design was the Warren Petroleum Corp. plant at Holiday, Texas where 80 percent of the cooling was done in air coolers. Direct fired heating of rich obsorption oil became the usual in design.

Natural gasoline men were once again asking themselves if they shouldn't go to gas conversion processes for making high octane gasoline. At the same time interest increased in LPG, Texas clamped down on the flaring of gas. By 1950 about 130 casinghead gas conservation projects were completed here. This included the processing of 2.75 billion cubic feet per day.

But even with the outstanding markets that had opened for LPG, much of the use was seasonal. It was then that underground storage of LPG developed. It had been tried with varying success in depleted oil and gas reservoirs. The first successful project was done by Chicago Oil Corp. in 1949, near the Feagil & Kinsey plant, Panola County, Texas. Propane was stored in a reservoir in the Paluxy Sand which appeared to contain only saltwater. An injection well and a relief well were used the first year.

This development was quickly followed in 1950 by successful storing of LPG in washed-out salt strata near the Kermit plant of Sid Richardson Gasoline Co. From then on, underground storage projects of this type and mined caverns have grown to a capacity of over 42 million barrels.

**Into The 50's.** During the early 1950s, it looked like many gasoline plants would be built along pipe lines such as the TGT plant at Gabe, Ky., one of the largest capacity plants ever designed (750 MMcf per day). It was unique in that the refrigeration process used chilled the entire gas stream to minus 96 F.

In the early 1950s it became evident that competition for natural gas was going to be very severe, and some companies turned to the building of portable plants. They featured low cost and portability in case the field's life was shortened. For other companies a portable plant served as a holding action in a new field.

In 1955 companies began to eye a new analytical tool —chromatography, which promised to reduce the cost of analytical equipment considerably. Developments in chromatography have continued to the present and, so far, its full use has not been realized.

In 1956, adsorption plants which had been out of the picture since the late 1920s were coming back on the scene.

As the octane race picked up full speed in 1955, two natural gasoline plants installed catalytic reforming— Texas Gas Corp. at Winnie, Texas, and Southwest Gas Producing Co. at Dubach, La.

**Unfinished Chapter.** As the natural gas plant operator looks to the future, he is faced with many problems the early natural gasoline plant man had. He still can produce more LPG than can be sold and still would like the refiner to use more front end volatility. Refiners, on the other hand, with their catalytic cracking capacities, are able to handle front end volatility with their own refinery system.

The natural gasoline man is still confronted with the seasonal demand for his products. But the worst problem he faces is that of octane. There have been some gasoline plant manufacturers who have put in upgrading facilities at their plants, but most of this is done at the refinery. Thus, more and more, the natural gasoline man finds his natural gasoline priced as a feed stock rather than a blending stock.

A bright spot in the gasoline fuel picture is the increased emphasis on isomers. A brighter future for the industry can be built on a return to engines requiring lower octanes and the possible development of turbine engines.

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# THE PETROCHEMICAL STORY

**Thomas C. Ponder and Frank L. Evans**
Petroleum Refiner Staff

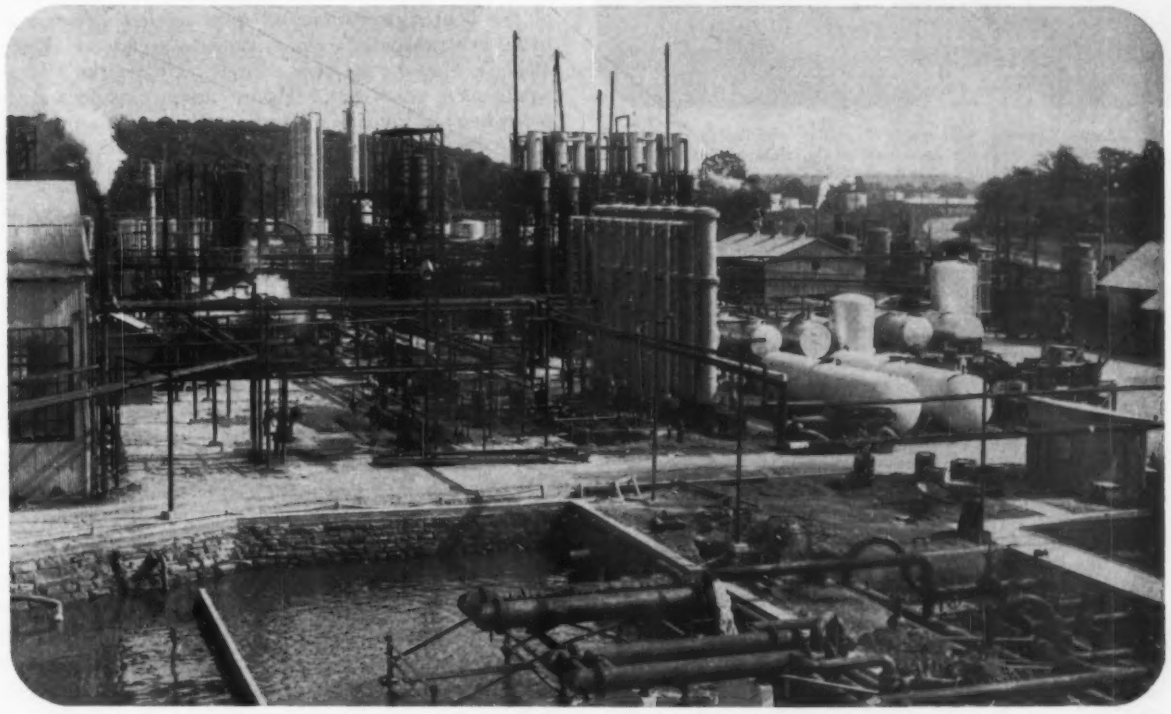
TO ESTABLISH the history for the petrochemical industry there must first be an understanding of the term petrochemical.

If you will agree that a petrochemical is a chemical product having a crude oil, natural gas or natural gas liquids origin, either totally or in part, then you will agree that the beginning of the industry was about 1916. This was the year Carlton Ellis discovered a method for making isopropyl alcohol from petroleum raw materials.

As in everything, a demand had created the spark of scientific interest to find a new way of making alcohol on a large scale. The demand in this case was the need for large amounts of acetone to produce explosives for World War I.

## GASOLINE IN SHORT SUPPLY

By 1919, the oil business and the automobile industry were booming so fast that many people felt there would not be enough crude oil produced to keep pace with the rising demand for gasoline.



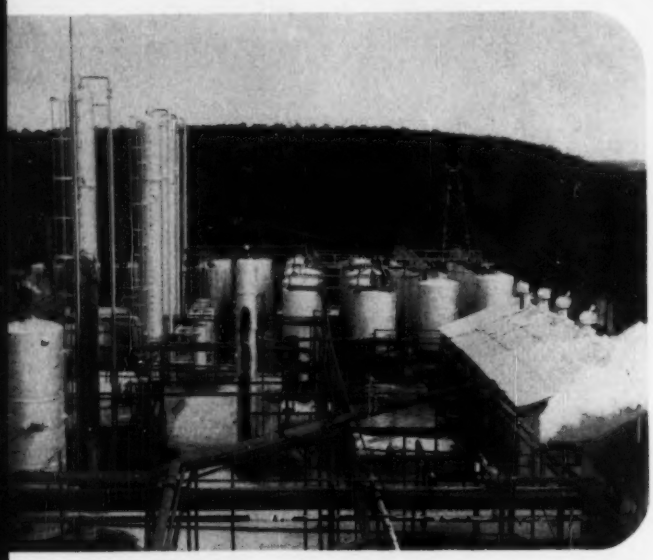
**While attempting to remove oxygen from natural gas, an accidental discovery resulted in the basis for this early petrochemical plant. Rather than going to carbon dioxide, the oxygen reacted with hydrocarbons to produce formaldehyde and methanol.**

The gasoline supply had to be extended, and one way to do this was to convert some of the gaseous parts of crude into alcohol and add it to gasoline.

Realizing the growth potential of converting oil into chemicals, Standard Oil Co. (New Jersey) acquired the Ellis patents in 1919 and constructed the first large petrochemical plant at Bayway, N. J.

By way of illustrating the economic change in petrochemicals, Standard's initial price for isopropyl alcohol was $6 per gallon. Today the same product, through the evolution of advancing technology, costs about 40 cents per gallon.

During the 1920s, the demand for chemicals from petroleum moderated and the industry activities were confined to new but small steps in the manufacture of the simple olefins—ethylene, propylene and the butenes.



**Distillation columns and maze of piping were early trademarks of petrochemical plants as shown in the view of the first Cities Service Refining Company plant at Tallant, Okla.**

**Early Entry.** An early pioneer in this field was the company now known as Union Carbide Chemicals Company. Starting in a small "shack" purchased from Clendenin Gasoline Co. in Clendenin, W. Va., Carbide has grown to one of the world's major producers of petrochemicals.

To illustrate the growth of simple olefins, in 1926 Carbide and Carbon Chemicals Company (as it was then known) made five compounds from ethylene and two from propylene. As early as 1939, Carbide was making 41 compounds from ethylene and 27 from propylene. Today, virtually every manufacturing or processing industry is dependent in some way on synthetic chemicals produced by Carbide.

In 1926 Union Carbide abandoned its plant at Clendenin and built a new works at South Charleston, W. Va. The exciting new product then was ethylene glycol. The following year it was marketed as the first commercial non-evaporating antifreeze. Thus, ethylene chemistry was off to a booming start.

## SOUTHWESTERN STIRRINGS

It was also during the early 1920s that the Southwestern area of the United States was feeling the boom from oil fever. The Empire Gas and Fuel Company, predecessor to Cities Service Oil Company, was operating a natural gasoline plant in Tallant, Okla. Dry gas had declined temporarily to the point where it was necessary to supplement it with casinghead gas from the Burbank field. When this was done, however, severe corrosion was immediately encountered because the Burbank gas was saturated with moisture and contained air in concentrations up to four percent. Something had to be done to make this gas suitable for use and eliminate the corrosion problem.

Empire engineers studied all possible corrosion prevention methods known at that time and decided the most feasible approach would be to deoxidize the gas by combining the oxygen with light hydrocarbons present in the gas stream. So, in 1927, the original plant started operation. To promote the reaction, a catalytic process was used which employed aluminum phosphate and small amounts of metal oxides as the catalyst. It was carried out under moderate pressures (100 to 300 psi) and temperatures (800 to 900 F).

**A Lucky Failure.** Unexpectedly and luckily, the controlled oxidation reaction did not proceed all the way to carbon dioxide; but instead resulted in a partial oxidation of the light hydrocarbons to form methanol, formaldehyde, acetaldehyde, acetone, dimethylacetal and higher alcohols. Had the gas been entirely methane, the reaction would have gone completely to carbon dioxide and the petrochemical industry might have died very young. Later it was discovered that traces of propane and butane in the gas stream were the hydrocarbons responsible for these attractive petrochemicals.

Empire immediately recognized the commercial possibilities of the controlled oxidation process and the petrochemical industry in the Southwest was born. At one time this one plant at Tallant, Okla. was responsible for more than 30 percent of the entire U. S. production of formaldehyde.

During the latter part of the 1920s, research tended to remain very active although the commercial products developed were few. Halogenation of the olefins proceeded along classical lines and the first commercial product—amyl alcohol, was made commercially from chloropentanes.

By 1930, Shell Chemical Company had entered into the chemicals-from-petroleum field. This took place at Pittsburg, Calif. when the world's first nitrogen fixation plant for ammonia manufacture using natural gas as a source of hydrogen started operating. First shipments of ammonia and ammonium sulfate were made in 1931 and steady expansion since that date has maintained Shell Chemical's position as a major supplier in the west-

ern U. S. of these important agricultural and industrial commodities.

At Martinez, Calif., Shell Chemical started utilizing refinery gases for conversion into synthetic alcohols and ketones, and successfully introduced its secondary butyl alcohol, methyl ethyl ketone, acetone and isopropyl alcohol to chemical markets.

### FIRST SYNTHETIC RUBBER

Olefins were the main building blocks for petrochemicals and an important discovery in this field was made in Europe in 1929. A method was found to convert olefins into olefin oxides by direct oxidation—traditionally, this had been done with hypochlorous acid. With this discovery the door was open for the manufacture of polyols without the problems associated with disposing of by-products.

However, many researchers were actively working on the use of by-products from the hypochlorous acid treatment of olefins to produce glycols. Also, much work was being done in trying to find a smooth way of hydrolyzing ethylene dichloride to the glycol in high yield. J. C. Patrick, in studying this problem, stumbled on the polysulfide polymers from which evolved the first synthetic rubber industry.

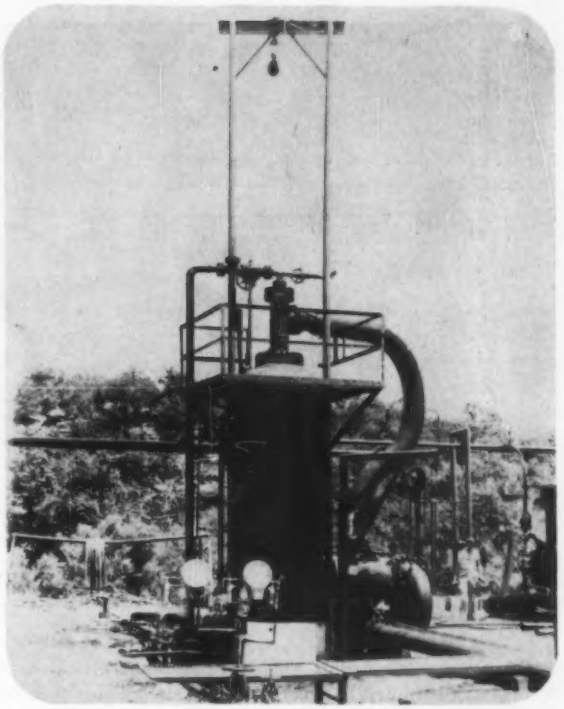
**Detergent Rise.** A reaction discovered in this country in 1930 lead directly to the tremendous detergent manufacturing industry. In this reaction, researchers found that secondary alkyl sulfonates can be made by direct sulfonation of paraffins with sulfur dioxide and chlorine. Alkylaryl sulfonates come from the alkylation of benzene, either with chlorinated kerosine or with a highly-branched olefin made from propylene and long chain olefins from secondary sulfates result from paraffin wax. These are the types of syntheses that confer detergent properties. Of course, today petroleum-based synthetic detergents far surpass soap in demand.

### THE RISE OF ETHYLENE

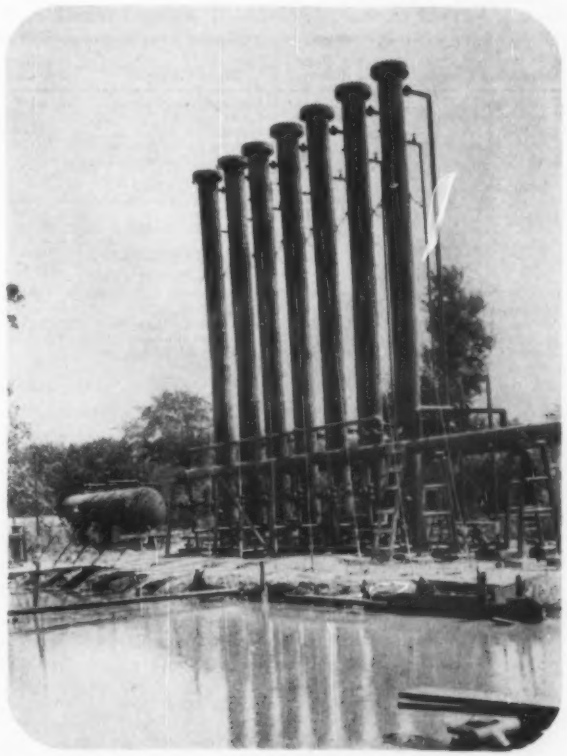
By 1932 ethylene production was becoming a fairly large and stable manufacturing process.

An excerpt from PETROLEUM REFINER's November, 1932, issue will give you an idea of the costs involved in operating an ethylene unit:

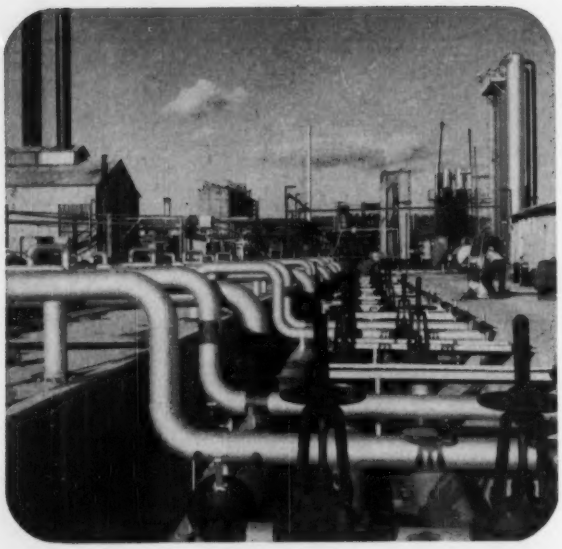
> While the refining industry may never engage in the manufacture of plastic resins, it may well study the advisability or its capability for supplying raw materials to the plastic resin industry. Ethylene, if produced in commercial quantities and cheaply, may be the source of additional revenues, since it is the essential raw material needed in the preparation of the new plastic resin chemically termed metastyrene. The refinery is the logical source of ethylene for this and other industrial applications.
>
> To make an ethylene plant an attractive investment, the ethylene should be produced at a total cost of under 6 cents per pound, which should include raw materials, yields, operating costs and fixed charges. In



**In this early day reactor, air and natural gas were mixed before the reaction to produce oxygenated petrochemicals.**



**Early day high-pressure absorbers. Notice the mixture of riveted and welded towers.**



**Petrochemicals used to make nail polish, plastics, antifreeze, and many other products were made at this Cities Service installation at Tallant, Okla.**

reference to the yields, the ethylene plant should have a relatively high efficiency when the percentage of plant yield will be low. The following costs are given for a plant that will produce ethylene which will be free of sulfur or acetylene:

| Operating Costs | Cost Per Day | Fixed Charges | Cost Per Day |
|---|---|---|---|
| Raw materials | $250.00 | Depreciation of plant | $ 30.00 |
| Steam consumption | 10.00 | Taxes | 5.00 |
| Electricity | 60.00 | Insurance | 2.00 |
| Condenser water | 20.00 | Interest on investment | 10.00 |
| Fuel Oil | 10.00 | Lease on plant site | 8.00 |
| Labor | 40.00 | | |
| Maintenance | 2.00 | | |
| Total | $394.00 | Total | $ 55.00 |
| | | Operating cost total | 394.00 |
| | | TOTAL COSTS PER DAY | $449.00 |

Total costs per year = $449.00 x 365 days = $162,885.00.
Assume plant is closed down for two weeks for cleaning, then plant will produce: 11,000 pounds per day x (365—14) = 3,861,000 pounds of ethylene.
Then: Cost to make ethylene = $162,885.00 / 3,861,000 lbs = $0.046 per pound.

A quick review of these data show that ethylene production economics haven't changed to a great extent. Larger capacity plants with specialized operations have, in fact, helped to keep the cost down.

**Birth of Polyethylene.** In 1933, two British chemists named Fawcett and Gibson were experimenting with ethylene at high pressures. They found that small amounts of catalytic material in the ethylene at high pressures resulted in rapid exothermic reaction and produced a tough thermoplastic resin very different from the soft waxy ethylene polymers produced previously. Thus, polyethylene became a reality.

Polyethylene production and development proceeded rapidly. In fact, so rapid that the commercial polymer resulted in less than five years where the normal course of a polymer development would have been several decades. By 1933 pilot plant production had reached one ton and before the end of 1940 production was 100 tons.

Commercial plants for the direct oxidation of ethylene to the oxide, which by-passed the chlorohydrin intermediate, came into their own by 1935. It can be said that this really opened the ethylene glycol market for exploitation for without this break-through in technical progress the methanol-ethylene glycol struggle might well be still continuing.

## AN INDUSTRY GROWS UP

Petrochemical processing, now out of diapers, was similar to the oil refining processes. It consisted of boiling off the various products, one at a time, and purifying them by fractionation. Some of the old refiners had to adjust to the new demands on controls though, when for example they found it was much harder to separate dimethylacetal which boils at about 148 F from methanol which boils at 151 F than to separate gasoline and kerosine in a bubble tower.

New standards of purity were required for their products, many of which had to meet the USP standards of drugs for human consumption.

By 1936 a high temperature substitutive chlorination of olefins process was discovered in America. This important step lead to the manufacture of glycerol and to new intermediates for the plastics industry.

It was this same year that Shell Chemical established petrochemical facilities at Dominguez, Calif. similar to those started in 1930 at Martinez for making derivatives such as methyl isobutyl ketone and methyl isobutyl carbinol.

**Birth of Butyl.** It was also around this time that two young chemists, Robert M. Thomas and William J. Sparks, experimenting with polyisobutylene in the laboratories of Standard Oil Company (New Jersey) discovered that small amounts of butadiene and isoprene could be copolymerized with isobutylene. This gave a polymer that could be vulcanized, whereas the polymers of isobutylene itself could not. Thus was born the new synthetic rubber to be called butyl when announced in 1940 by Jersey Standard.

The year of 1937 also saw Ethyl Corporation begin manufacturing tetraethyllead from lead, salt and hydrocarbons which were obtained from Standard's Baton Rouge refinery.

The tempo of petrochemical growth at this time began to increase. Acetic anhydride from ethylene through synthetic ethyl alcohol and from propylene via acetone was established for the manufacture of cellulose acetate. Also discovered was the production route of nylon salt from butadiene and the isolation of *p*-xylene from petroleum xylenes to form another of the new synthetic fibers. Synthesis of acrylonitrile from ethylene and acetylene produced the nitrile fibers.

**Many Uses.** Plastics now coming to the scene in the middle 1930s needed a wide variety of petrochemical raw materials. Styrene, vinyl chloride, polyethylene, formaldehyde from petroleum derived methyl alcohol and urea

from petroleum-derived ammonia were the likely prospects for chemicals from petroleum.

Increasing interest in synthetic rubber resulted in the first importation into the United States of nitrile rubbers from Germany. These were copolymers of butadiene and acrylonitrile and because of their resistance to oils and hydrocarbon liquids, their use appeared essential to the upcoming war effort.

By 1938 polyethylene plastic had really become commercial. This year marked the production of the first ton of this "squeeze bottle" material and it was made by Imperial Chemicals.

**End of the 1930s.** The latter stages of the 1930s saw three important developments. In 1937, Esso Standard Oil Company of Louisiana, a Jersey Standard subsidiary started the commercial production of naphthenic acids from by-product streams at the Baton Rouge refinery. This was the opening of the commercial route for nylon through the isolation of cyclohexane.

In 1938, E. I. du Pont de Nemours & Co., Inc., first introduced nylon. This was the first of the polyamide resins and was actually the beginning of the truly synthetic fiber industry in the United States.

Then, in 1939, the Dow Chemical Company began marketing vinylidene chloride resins under the trade name of Saran. In 1942, however, Dow gave to the public all rights to the trade name Saran and thus it became a generic term for all vinylidene chloride resins.

As the 1930s came to a close, this country was quite actively engaged in all forms of petrochemical research and product development. Indeed, this was truly fortunate, because although we didn't realize it at the time it constituted the beginning to our all-out World War II effort.

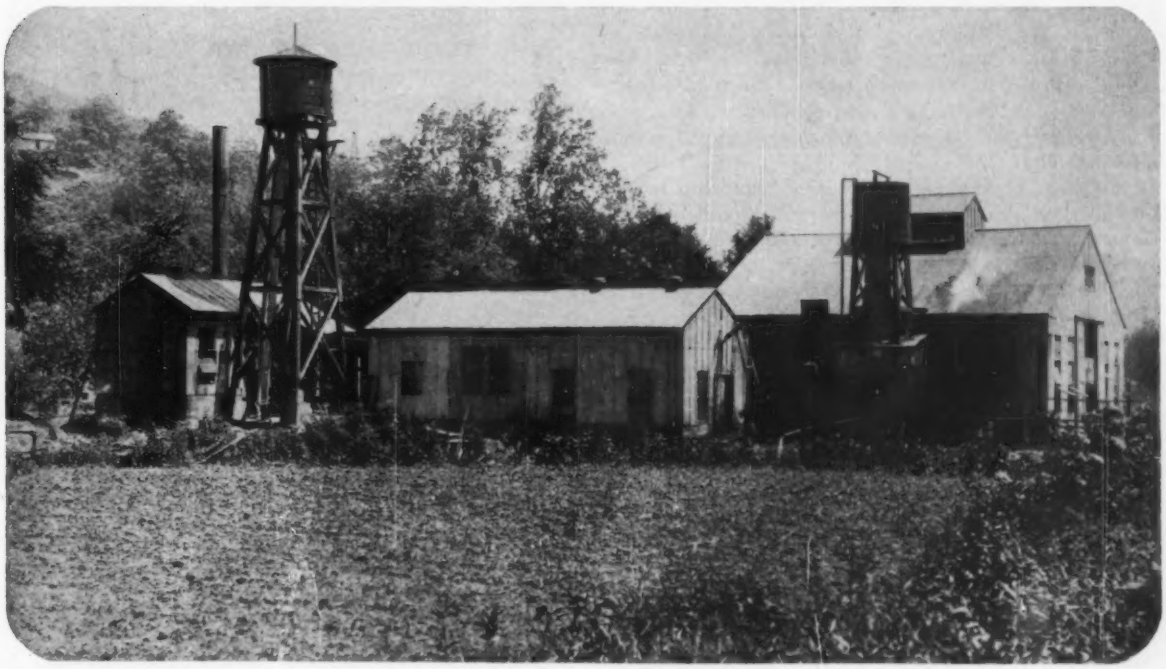
## The War Years

ONLY FIVE oil companies in the United States were making petrochemicals prior to 1940. They were: Standard Oil Company (New Jersey), Cities Service Refining Company, Shell Oil Company, The Pure Oil Company, and Standard Oil Company of California. There was practically no petrochemical industry outside of this country at that time and it was not until after World War II that any significant petrochemical industry was started elsewhere. Polyethylene was still moving quite slowly as by 1940 a mere 100 tons had been produced by Imperial Chemicals in England.

However, in June of 1940, Standard Oil Company (New Jersey) not only announced the commercial development of a process for making butyl rubber but also made available test quantities for those desiring it. Then in May, 1940, nitro alkanes became a commercial reality when the Commercial Solvents Corporation began operating a plant producing 4,000-5,000 pounds of nitroparaffins a day. This was the beginning of the nitromethane industry in this country.

During this same year, the beginning of the Shell Chemical complex at Deer Park, Texas, was started with acetone, isopropyl alcohol and butadiene as its initial products.

**Gulf Coast Grows.** By 1941, the war in Europe was in full swing and war clouds were gathering over the United



**The original Clendenin plant of Union Carbide Chemicals Company was merely an old barn.**

States. It became evident that huge amounts of petrochemicals would be invaluable to the Allies for an impending war effort and therefore three new plants were built on the Gulf Coast. Union Carbide Chemicals Company completed its plant next to American Oil's refinery at Texas City to convert olefins from the refinery to alcohols, glycols, ketones and esters.

Shell Chemical completed a plant adjacent to the Shell Oil refinery at Deer Park to produce isopropanol, acetone and butadiene.

Dow Chemical's new plant at Freeport, Texas, used oil, natural gas, LPG, sea water, oyster shells and salt to make carbon tetrachloride, percholoroethylene, ethylene glycol, diethylene glycol, triethylene glycol, propylene glycol, styrene, polystyrene, methylene chloride, ethylene dichloride, chloroform and hexachloroethylene.

Just prior to this large petrochemical expansion, Standard Oil Company (New Jersey) had put into operation a steam cracking refining process which made available large quantities of chemically reactive gases at low cost. These gases were to form the basis for additional petrochemical activities so fortunately our war effort got another early boost.

### RUBBER NEEDS FELT

During the early months of 1941, the government synthetic rubber program was just getting under way. It was none too soon either, as the first of the program for GR-S rubber was started when imports of natural and synthetic rubbers were dwindling to nothing. The first production of nitrile synthetic rubbers was started and Standard Oil Company (New Jersey) began producing 15 tons a day of the copolymer—acrolynitrile-butadiene—at its Baton Rouge refinery. By September of that year, three months before Pearl Harbor, Phillips Petroleum and B. F. Goodrich, in a joint operation, were producing nitrile rubbers at the rate of 25 tons a day.

During this same year butyl rubber, which had been discovered in the 1930's, first went commercial. This was one more new synthetic rubber which contributed much to the war effort.

It was also in 1941 that increasing demand for higher alcohols caused Jersey Standard to begin operation of an oxo plant at Baton Rouge to produce isooctyl and other higher alcohols.

**Production Climbs.** By 1945 government-owned plants operating under contract by industry for the production of butadiene-styrene GR-S synthetic rubber reached 790,000 tons a year. This was the first successful production of synthetic rubber from petroleum sources (the Germans had synthesized rubber in large quantities but their production was from coal derived butadiene and styrene). Actually, the United States became a net exporter of synthetic rubber to the Allies.

**Toluene from Oil.** For years all toluene had been made as a by-product of the steel industry. By 1942, however, war requirements for explosives required a vastly greater amount of this chemical for TNT.

Fortunately Jersey Standard research had already lead to the first production of toluene from petroleum. Therefore, in the Standard refineries and others, this petrochemical was made in such large quantities as to replace the known methods of producing the original chemical.

Toluene production had boomed during the war and by this time more than 83 percent of the total U.S. production of toluene came from petroleum. By the end of the war, however, toluene from all sources was in over-supply and hence petroleum producers made only enough for long term contracts and gasoline blending.

**Other Petrochemicals.** Non-catalytic oxidation of butane and propane in the gaseous phase was started by Celanese Corporation of America at Bishop, Texas, in 1945. A complex mixture of organic compounds was made containing formaldehyde, methyl alcohol, acetaldehyde, acetic acid, *n*-propyl alcohol, methyl ethyl ketone and oxides of ethylene, propylene and butene. These products were separated into marketable petrochemicals by a series of complex fractionation operations.

Close to the end of the war Shell Chemical at Deer Park added allyl chloride and allyl alcohol to its list of products, signaling the start of a new chemical industry based on allyl compounds derived from petroleum hydrocarbons. Synthesis of allyl chloride by direct substitutive chlorination of propylene led to two new unique and distinctive products: synthetic glycerine, which went into commercial manufacture at Deer Park in 1948, and epoxy resins.

The production capacity which petrochemicals had reached during the war put the industry in good position for the tremendous demand for consumer goods which followed almost immediately.

## Post War Expansion

SYNTHETIC RUBBER capacity, although cut back because of the end of World War II, was still being researched and improved in 1946. Polymerization temperatures of 41 F. produced a synthetic styrene-butadiene rubber having superior physical properties over the old "hot" rubber. Thus "cold" rubber was born.

Along with "cold" rubber came oil masterbatching and the blending of carbon black reinforcing materials into the latex during polymerization. These and other developments added to the improvements in synthetic rubber.

**Detergent Rise.** Increasing acceptance of synthetic detergents to replace soap prepared the way for synthetic glycerine production. In 1947 Shell Chemical started producing glycerol from propylene and chlorine at Deer Park. Here was a synthetic product equal in every way to the natural product and available at stable prices from a very reliable source.

By 1948 Standard Oil Company of California had entered the phthalic anhydride field to be the first petrochemical producer of this dibasic acid. *o*-Xylene from petroleum was the starting material and California Standard was thus independent of the naphthalene supply.

It was during this same year that the first commercial synthetic ethyl alcohol plant was placed on stream by

**Blaine's Island and the Carbide plant about 30 years ago.**

**This is the over-all view of the petrochemical complex of Carbide at South Charleston today.**

Shell Chemical at Deer Park. This was the first plant to use direct catalytic hydration of ethylene to ethyl alcohol.

**Oxo Reaction.** The Fisher-Tropsch reaction and its first cousin the oxo reaction had been known for some time. However, demand for higher alcohols did not warrant a commercial plant for their production until 1948 when Standard Oil Company (New Jersey) placed the first commercial plant on stream using the oxo reaction for production of these alcohols.

Another development this year was the production of hydrogen cyanide from ammonia, methane and air. Although the basic patents had been issued in 1933, it was not until 1948 that basic work by Freeport Sulfur Co. led to its commercial fulfillment.

### THE FABULOUS 50s

Shell Chemical, at its Deer Park plant, began production of epoxy resins in 1950. This provided a new class of such resins as a base for paints, adhesives, laminates and castings.

It was also in 1950 that acrylic fibers were initially introduced commercially by Du Pont. This was the first of a series of fibers based on acrylonitrile polymers and copolymers.

Another company which entered the synthetic fiber field in 1950 was Union Carbide Chemicals Company which introduced its acrylic fiber to the trade. This was a coplymer of vinyl chloride and acrylonitrile.

Already synthetic fibers were making a place for themselves. Total production, exclusive of rayon, stood at 125 million pounds, and this was just the beginning of a tremendous industry.

The vapor phase hydration of propylene for the commercial production of isopropyl alcohol was begun in 1951. This eliminated the necessity of joint production of acetone when making synthetic isopropyl alcohol.

**New Process.** By 1952 the demand for water soluble oxygenated petrochemicals had increased to such an extent that standard processes could no longer keep pace with demand. Celanese Corporation of America, at its Pampa, Texas, plant, oxidized butane with air in the liquid phase. Main petrochemical products were methyl alcohol, acetaldehyde and acetic acid. While acetic acid was the main product, the process could be changed to give methyl ethyl ketone as the principal product.

The year 1953 marked the beginning of a new class of synthetic fibers. Du Pont introduced its new polyester fibers which was an ester of terephthalic acid and ethylene glycol. Terephthalic acid is derived from petroleum *p*-xylene and, of course, ethylene glycol is a petrochemical of ethylene.

Direct oxidation of LPG petrochemical production in 1954 used 230 thousand tons of propane and butane. This process accounted for seven percent of the methyl alcohol and 25 percent of the formaldehyde produced in the United States.

**A New Rubber.** The first announcement of the synthesis of synthetic natural rubber was announced by the president of B. F. Goodrich Company in December, 1954. Details of the properties and tests were given by the director of research and development for Goodrich in November, 1955. This material was 99 percent *cis*-polyisoprene. Again, man was able to duplicate nature and, in this case, the synthetic even exceeded certain properties of natural product.

It was during this same time that B. F. Goodrich also announced its newest contribution to the synthetic fiber field. This was a vinylidene-dinitrile fiber suitable for high bulk cloths such as deep-pile coats.

By 1956 rubber research was still taking giant strides toward developing new products. Phillips Petroleum announced the preparation of a polybutadiene of high *cis* content in April of that year. This polymer of butadiene had properties which made it superior to natural rubber for large truck and bus tires.

This was also the year in which Union Carbide Chemical began to market high purity peracetic acid. This marked the beginning of commercial availability for this highly reactive material for organic oxidation reactions.

**Polyethylene Build-Up.** In February of 1957, Celanese Corporation of America placed the first commercial plant in operation for producing high density polyethylene using the Phillips process. Then in March, 1957 Phillips Chemical also came onstream in Houston with another Phillips high density polyethylene plant. W. R. Grace followed with its new plant at Baton Rouge using the same process in December.

Hercules Powder Company started operation of a high density polyethylene plant at Parlin, N. J., using the Ziegler process. This marked the first entry of this alkyl metal catalyzed polyethylene process in this country.

All of these entries into the low-pressure polyethylene field jumped capacity of high density polyethylene from near nothing to an excess of 200 million pounds per year.

Hercules Powder Company became the nation's first commercial producer of polypropylene when its Parlin, N. J., plant began operating in December, 1957. This was "isotactic" polypropylene based on research done by Dr. Giulio Natta in Italy.

**Another Fiber.** Goodyear Tire & Rubber announced a new polyester fiber in 1958. Research which was begun in the 1940s for improved tire cord yarn resulted in this new family of polyester resins. Although not especially suited for tire use, they do offer exceptional characteristics when used alone or in blends with natural fibers in the clothing field.

Another development of last year was Jersey Standard's decision to build a 40 million pound-per-year polypropylene plant at Humble's Baytown, Texas, refinery. This announcement climaxed more than two years of extensive pilot plant work at Esso's research facility in Baton Rouge.

### PETROCHEMICALS TODAY

Petrochemicals are principally a Southern product with locations along the Gulf Coast accounting for more than 80 percent of the petrochemical industry. This is only natural considering the availability of raw materials and the necessarily close relationship between petroleum refining and petrochemicals. Frank J. Soday, vice president for research and development for Chemstrand Corpora-

tion, has predicted that by 1968 over 50 percent of all the chemical industry would be located in the South.

Well over $1 billion was spent on new plant construction for petrochemicals and petroleum derived organic chemicals in 1958. There seems to be no reason to expect this growth trend to go any way but up. Thus petrochemicals will continue to be the fastest growing industry in America. Foreign petrochemical construction is also beginning to go forward at a very dramatic rate. Aims of the European are to take care of local demand and to limit the need for imports. However, even with this foreign growth and the lessening of export markets, U.S. petrochemical capacity should easily triple by 1975.

**Unlimited Capacity.** Many of the well-known reactions and processes have not been fully exploited. For example, the oxo reaction has been used primarily for production of higher alcohols. Stopping short of the final hydrogenation and producing many different aldehydes could open up unlimited capacity for these long chain aldehydes. Their ultimate utilization merely awaits research to discover how to use them. Thus, the oxo reaction, tried and proved, can give petrochemicals a solid future.

Synthetic fibers have been mentioned earlier. Because of the rapid growth in population, however, natural fibers just can't keep pace with demand. It is estimated that synthetic fiber production should exceed 4 billion pounds per year by 1975. This compares to about three-fourths of a billion pounds in 1958. You can see the potential for petrochemicals is unlimited.

No doubt the petrochemical industry owes much of its growth to petroleum. And yet, petrochemicals use only a small portion of the crude petroleum and natural gas produced (it is estimated petrochemicals will utilize only about three precent of all crude petroleum and natural gas produced by 1965). Today, more than 3,000 different organic chemicals can trace their origin to petroleum and natural gas fractions. These organic chemicals from petroleum, or petrochemicals, account for more than 80 percent of all synthetic organic chemicals produced today.

**Big Business.** Petrochemical producers are big business. Here's how petrochemicals affect the sales of products by eleven large chemical companies:

1. Allied Chemical Corporation credits about 36 percent of total sales to petrochemicals.
2. American Cyanamid, excluding the pharmaceutical division, has petrochemical sales amounting to 40 percent of total sales.
3. The Dow Chemical Company, one of the most important domestic petrochemical producers, has petrochemical sales of about 60 percent.
4. E. I. du Pont, while concentrating on finished products, has over 50 percent of its sales in petrochemicals.
5. Hercules Powder has petrochemical sales of 15 percent but estimates within the next few years this is going to go more than 25 percent.
6. It is estimated more than 25 percent of Hooker Electrochemical Co.'s total sales were derived from petrochemicals.
7. Of Monsanto's total sales, excluding drugs, over 65 percent is derived from petrochemicals.
8. Olin Mathieson Chemical Company has current sales of petrochemicals amounting to almost 15 percent of total sales.
9. Of the combined sales of products from Rohm & Haas, petrochemicals amount to an estimated 60 percent of total sales.
10. Total sales of petrochemicals by Spencer Chemicals Company amount to 90 percent of total sales.
11. Practically all of Union Carbide Chemical Company's sales are petrochemicals and these account for about 50 percent of total sales of Union Carbide Corporation.

Petroleum refining companies are also engaged more or less directly in the petrochemical industry. Here are a few of these and the percentage of their total sales attributable to petrochemicals:

- Phillips Petroleum Company among the leaders in petrochemical production, has 15 percent of its total sales in petrochemicals.
- Shell Oil, one of the most diversified in petrochemicals of all the oil companies, estimates that 10 percent of its gross sales is in petrochemicals.
- Approximately five percent of Standard Oil Company of California's sales are in petrochemicals.
- Standard Oil Company (New Jersey) is one of the major petrochemical producers in the United States with petrochemical sales equal to about four percent of total sales.

**Many More.** Other companies which have diversified into petrochemicals are:

**Synthetic Ammonia:** Commercial Solvents, Standard Oil Company (Ohio), W. R. Grace, John Deere, Atlantic Refining, Pennsylvania Salt, and Food Machinery and Chemical.

**Polyethylene:** National Distillers, W. R. Grace, Eastman Kodak, Celanese, and Koppers Company.

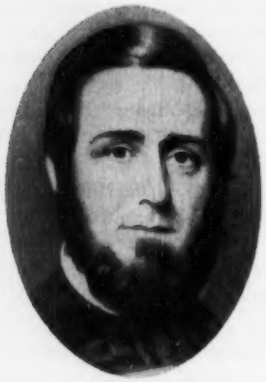
**Vinyl Plastics:** Goodrich, U.S. Rubber Company, General Tire, Firestone, Diamond Alkali and The Borden Company.

**Synthetic Rubber:** Through acquisition of government-owned plants Firestone, General Tire, Goodrich, Goodyear, and U.S. Rubber Company have entered the petrochemical field.

The dramatic growth of the petrochemical industry seems to have grown from forces set in motion during World War II. In the beginning they were substitutes for materials in short supply because of the war. This situation has changed remarkably and now petrochemicals are the preferred product. With this growth has come stable supply, reliable prices and predictable supplies for the future. The petrochemical industry has truly carved a niche for itself in the history of this country.

## Chapter 2: The Men

# REFINING HALL OF FAME

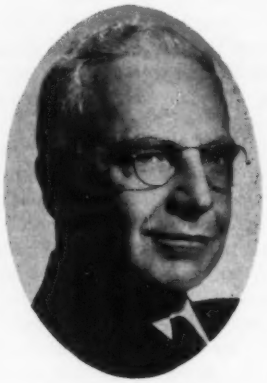


KIER

Samuel Martin Kier (1813-1874), born near Pittsburgh, Penn., has been referred to by some as America's first oil refiner. He first became commercially associated with oil in 1846 when he introduced it as a medicinal cure-all called "Petroleum or Rock Oil." When this failed, he turned his attention to other possible uses for oil and as a result built the first refinery in America which was nothing more than a crude oil barrel still. His first attempt at distillation was rewarded with a thin trickle of amber fluid which burned brightly, but which retained its offensive smell. Many others would have given up at this point, but not Kier. Finally he increased the size of his still, started rerunning the product and came up with a good usable "carbon oil" which found a ready market. When Drake's well came in, Kier provided an outlet for all of the crude. Thus he was not only the pioneer of oil refining, but was the first marketer as well. He died in Pittsburgh at age 61.

DUBBS

Carbon Petroleum Dubbs (1881-19—), born in Franklin, Penn., will long be remembered in the petroleum industry for his famous Dubbs cracking process. Most of the research work was done at Standard Asphalt and Rubber Co., and National Hydrocarbon Co. (which later became Universal Oil Products), and in March, 1919 he filed an application for a "clean circulation" cracking process. Here for the first time was a development which enabled refiners to run residual fuel as a charging stock in the place of the more expensive gas oil; thus the yield of gasoline was practically doubled. In subsequent years, Dubbs cracking units became common-place in refineries all over the world, and were even more successful than the optimistic had forseen. C. P. Dubbs headed the UOP research and devepoment department until 1930 and thereafter became an unpaid consultant. At present he lives in Bermuda, although he still retains an active interest in the oil industry.



KALICHEVSKY

Dr. Vladimir A. Kalichevsky (1896-1958), internationally known in the petroleum field, authored books including "Chemical Refining of Petroleum," Modern Methods of Refining Lubricating Oils," "The Amazing Petroleum Industry," and "From Oil Well to Engine," plus more than 50 articles in technical magazines. Kalichevsky received his early education in his native Russia where he earned a doctor of military science degree. He received a degree in chemical engineering from California Institute of Technology after coming to the United States. During a career that brought him fame as an author, lecturer, research chemist and world authority on petroleum refining, he developed Thermofor catalytic cracking, continuous wax moulding, dualayer gasoline treating, and dualayer distillate treating. Listed in "American Men of Science," Dr. Kalichevsky was one of nine petroleum industry leaders named in "Leaders in American Science."

HISTORY IS NOT MADE without some men rising above the others in outstanding feats and accomplishments—and here for the first time are those individuals who rose above all in the history of oil processing—those who have been elected to the Refining Hall of Fame.

Certainly, it is only fitting that this oil centennial year be selected as the time to initiate the project which has long been needed in the petroleum industry. Now these eight men are assured of permanent recognition by the industry to which they dedicated their life's work—with the actual selections coming as the result of many months of combined efforts of readers and editors of PETROLEUM REFINER.

In addition to honoring these men in this special Oil Centennial Issue, PETROLEUM REFINER is making copper plaques which will bear an etched likeness of each man and a few brief words relating to his contribution. These plaques will be hung in an appropriate place so that all Americans will come to know and remember these men who contributed so much to the industrial, economic and technological advancement of this country.

Then every few years as history enables us to view past accomplishments in the light of how they have affected out great industry, new names will be added to this Honor Roll.

**HOUDRY**

Eugene J. Houdry 1892-19—) received his education in France, graduating in 1911 from the University of Chalons with an A.M. degree in mechanical engineering. He entered the steel industry and later became interested in the making of liquid and gaseous fuels by the destructive distillation of lignite and coal in the presence of catalysts. Houdry also investigated the purification of motor fuels and gas. In 1930, Vacuum Oil Co. invited him to the United States to develop his processes, and from that time Houdry's research and development work has continued under his direction in this country. The significance of his invention is hinted by the fact that 75 percent of the 100 octane aviation gasoline used by the Allies early in World War II was made by his process. He has headed Houdry Process Corp. since 1931. In 1950 Houdry organized Oxy-Catalyst, Inc., of which he is president, to manufacture his oxidizing catalyst.

**BURTON**

Dr. William M. Burton (1865-1954) is noted for developing the first successful cracking process to make more gasoline out of crude oil. He thereby became the father of modern petroleum refining technology. Dr. Burton's process was but a germ of an idea when, in 1909, he perceived that gasoline demand was growing so rapidly that refiners would soon be hard pressed to meet it. The problem was that crude oil in its natural state had only about 18 percent of gasoline-suitable molecules. Petroleum product production by chemical change rather than by physical separation seemed to hold the answer. So, Dr. Burton began the first industrial laboratory work toward this end. The Burton processes' principles contributed greatly to modern refinery practice, and gave it that flexibility which enables it to adjust to market needs the ratio of petroleum products. For this, the API awarded Dr. Burton the Gold Medal for Distinguished achievement.

**BROWN**

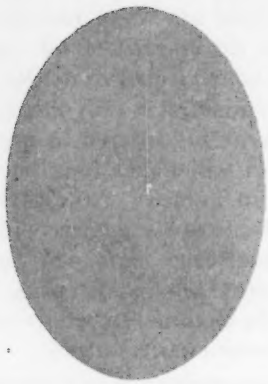
Dr. George Granger Brown (1896-1957) professor of chemical engineering at the University of Michigan for 37 years, is famous for his work in thermodynamics, vapor pressure and vaporization of the volatile hydrocarbons, automobile engines, and improved cracking plant design. Efforts toward a textbook resulted in the first section of "Natural Gasoline and the volatile Hydrocarbons." He later added a book on unit operations. Dr. Brown's colleagues recognized his contribution to engineering through the AIChE William H. Walker Award in 1939, and NGAA's Hanlon Award in 1940. The University appointed him Edward De Mille Campbell University professor of chemical engineering in 1947, and in 1951 he became dean of the College of Engineering. Dr. Brown was selected to give the Henry Russell Lecture in 1955. He was noted for his work in professional societies and engineering education.

EGLOFF

Dr. Gustav Egloff (1885-1955) was often referred to as "Mr. Petroleum" throughout the world. Formerly a director of Universal Oil Products Co. he was the holder of more than 300 oil processing patents and author of 650 articles and 11 books, primarily on cracking and refining. He was particularly noted for his work on the physical constants of hydrocarbons, emulsions and foams, reactions and isomerization of pure hydrocarbons, catalysis and alkylation of alkanes. Awarded 22 honorary degrees, fellowships and awards, Dr. Egloff was also a member of 17 technical societies, and was an officer in most of them. He began a distinguished career after receiving an A.B. degree from Cornell University, and M.A. and Ph.D. degrees from Columbia University in 1913 and 1915 respectively. He was with the U.S. Bureau of Mines in 1915, became chief chemist for the Aetna Chemical Co. in 1916, and director of research for UOP in 1917. Dr. Egloff contributed vitally to the development of petroleum as a major source of energy and as an important source of hydrocarbons for raw materials in chemical manufacture. He constantly strove to focus the layman's attention on the far-reaching effects of the petroleum industry on civilization. His vast knowledge earned him a reputation as a walking encyclopedia of petroleum. This is reflected in his past memberships in numerous technical committees, many of which he served as chairman. His accomplishments and endeavors notwithstanding, Dr. Egloff was known as a very human friend who gave unstintingly of his time and energy toward establishing more successful careers in scientific fields.

IPATIEFF

Vladimir N. Ipatieff (1867-1952) had a career so productive and so unusually long, that he laid the basic foundation of modern catalytic technology and yet, years later, developed processes in current use. A native Russian, he studied chemistry in Europe from 1896-1897. In 1907 the chair of chemistry at the University of St. Petersburg was added to his duties. During World War I, as a lieutenant general, he mobilized the Russian chemical industry. His distinction prevailing over his important family connections, he continued to hold high office in the Soviet regime. However, matters became increasingly distasteful and he decided to leave Russia. He came to the United States in 1931 as a lecturer in chemistry at Northwestern University, and as research director of Universal Oil Products Co. Ipatieff early became interested in heterogeneous catalysis. Suspecting that high pressures would facilitate the hydrogenation of organic compounds, he constructed the first practical experimental autoclave for working at high pressures—the famous "Ipatieff Bomb." He discovered high pressure hydrogenation and devoted much of the next 50 years to exploitation of this discovery in a wide array of catalytic and high pressure investigations. His pioneer work had a revolutionary effect upon laboratory and technical procedures and in many branches of chemistry. His 20 years in the United States was rich in accomplishment both in pure chemistry and in technology. He is noted for discovering the solid phosphoric acid catalyst, the alkylation of olefins by isoparaffins and his work on the isomerization of alkanes.



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This space is reserved for those tens of thousands of men who have worked in the oil, gas and petrochemical processing industry during this one-hundred year span. Certainly none can deny that the combined efforts of each of these individuals contributed a great deal toward making our industry and this country as great as it is today. The history is strewn with those who put forth just as much effort on their projects as did these other eight members of this "Refining Hall of Fame" but whose results were perhaps not so spectacular. Therefore, the editors of PETROLEUM REFINER are reserving this space for all those individuals—for those early-day refiners who with nothing more than bailing wire, a teakettle and a great deal of ingenuity and fortitude managed to put enough plants "on stream" to keep up with the terrific production which so closely followed Drake's discovery well. It is also reserved for those two men who spent Christmas day at the newly-built Corsicana, Texas, refinery just to fire the boilers so that the plant could start operating as quickly as possible —and to the thousands of men since then who have worked at the construction and start-up of hundreds of refineries all over this nation. It's reserved for those hardy individuals who fought the Acme Oil Co. refinery fire at Titusville in 1880 and those loyal employes who fought the fire at Indiana Standard's Whiting refinery in 1955. It's reserved for the maintenance men who kept our refineries operating and to those in R & D who keep coming up with new products and new ways to make them. But, most of all, this space is reserved for you and your associates—vital cogs in this gigantic oil machine.

## Chapter 3: The Future

# THE ENERGY PICTURE IN 1984

THIS chapter is somewhat of a departure from what you have just finished reading, in that it devotes itself not to the past but rather to the future. More specifically, it deals with certain phases of life which we think will become realities within the next 25 years.

For instance, we believe that by 1984 you will be using instantaneous language translators to benefit intercountry understanding; that air travel at 5,000 mph and faster will be commonplace; that mail will be delivered within this country and across the oceans by guided missiles; and that electroluminescence or cold light will be widely used in plants, homes and highways.

On the more personal side we also think that famine will be eliminated through new biological advancements, irrigation, and flood control; that man's life will be reaching 100 years; and that one of his most important problems will be how to make use of his leisure time.

To accomplish these things, however, will require a tremendous amount of energy. To enable us to talk in more simple terms, the energy statisticians have devised a unit they choose to call "Q," which is equal to $10^{18}$ Btu. It is estimated that from the beginning of the Christian era, the population of the world has spent somewhere between 10 and 13 Q of inanimate energy. Where the energy will come from within the next 25 years is the main topic of this chapter.

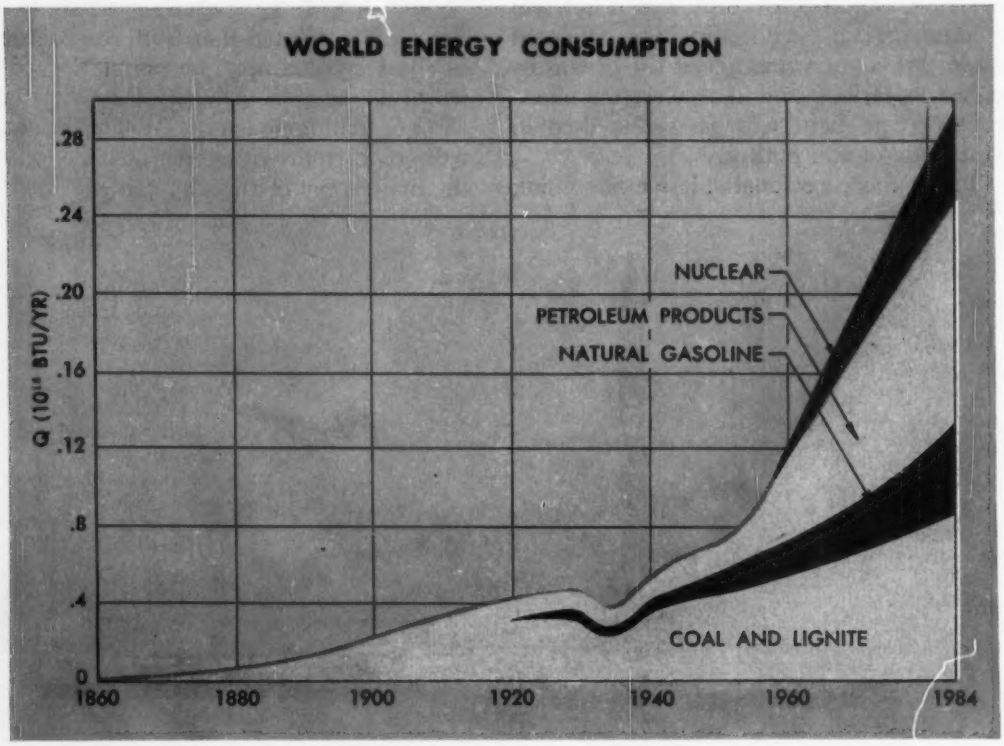
# WORLD ENERGY AND WORLD OIL

**Nathaniel B. Guyol**
Standard Oil Company of California, San Francisco

THE FIRST HUNDRED YEARS of the petroleum industry have been years of phenomenal growth. World production of crude oils has increased from 16 barrels to 19 *million* barrels daily. The increase has been not only rapid but almost without interruption. Over the 100-year period, production and consumption have risen at an average rate of 15 percent per year.

Setbacks have occurred, but they have been relatively small in magnitude and short in duration. The worst was the one that accompanied the great depression, when oil production fell 12 percent in three years—from 4.3 million bpd in 1929 to 3.8 million in 1932. By 1934, however, production had bounced back above the 1929 level.

**Globe Circling.** In only a hundred years the industry has thus developed from a few scattered wells in Penn-



"Crude oil is now the world's most valuable mineral product worth about $20 billion per year with gross annual industry sales of about $60 billion."

sylvania and Romania to what is perhaps the largest and most widespread industry in the world. Oil has been found and developed in 52 countries; refineries have been built in 64; and markets have been established in every one of the world's 200 countries—from Aden to Zanzibar.

Crude oil is now the world's most valuable mineral product, worth about $20 billion per year, and gross annual sales of the industry are in the vicinity of $60 billion.* This is somewhere around six percent of the world's expenditures for all purposes.

This remarkable growth has been due in part to the displacement of other sources of energy—coal in particular. Roughly 50 million tons of coal per year have been displaced by fuel oils in ships' bunkers. In railways, 150 million tons or so have been displaced by oil. And in the household sector, somewhere around a hundred million tons of coal have been displaced by oil or natural gas.

Altogether, however, displacement probably accounts for less than one-sixth of the present market for oil; most of the market has developed out of increases in total energy requirements, coupled with oil's technical and economic advantage over other sources of energy in meeting certain of those requirements.

World requirements for energy from commercial sources rose from 4 x $10^{15}$ Btu's yearly in 1860 to 108 x $10^{15}$ Btu's in 1958. Until 1915, coal provided 90 percent or more of this energy, and kerosene most of the remainder.

**More Oil Use.** A change in the pattern of demand appeared during the latter years of World War I, mainly as a result of the rapid development of automotive transportation. By 1919, petroleum's share in the total energy market had risen to 10 percent, and oil had established a foothold in the bunker trade of merchant and naval vessels. The use of oil by such vessels, almost negligible at the outbreak of the war, then amounted to around 50 million barrels yearly. Oil had also become a significant source of energy in manufacturing, in railway transportation and in gas-making, especially in the United States. U.S. factories used 90 million barrels of fuel oil in 1919, railways an estimated 30 million barrels, gas works 23 million barrels and power plants 11 million barrels.

The following ten years saw a particularly rapid growth in the oil industry, a growth due primarily to the development of the automobile, but stimulated by repeated coal shortages brought on by strikes among coal miners—first in the United States, then the Saar, and finally in Britain. During this period the use of petroleum nearly trebled, and oil's share of the total energy market rose to 18 percent.

The next sixteen years were relatively poor ones for the petroleum industry. Total energy requirements, affected first by the depression, then by World War II, increased by only 12% in the entire period. Oil's share of the energy market rose to 27 percent by 1945, but the rate of increase in oil requirements averaged only a little over 3 percent per year over the period.

**Sharp Rise.** The postwar years have seen the restoration of more normal rates of growth in the world energy market. Between 1945 and 1958, the world's total energy requirements rose from 56 x $10^{15}$ Btu's to 108 x $10^{15}$ Btu's, or at a rate of nearly 5.5 percent a year. Requirements thus almost doubled during this period, but supplies of coal, the major source of the world's energy, rose by less than 50 percent.

Natural gas made up part of the difference, but the main burden fell on oil. As a result, world oil requirements rose 167 percent between 1945 and 1958, from

* Estimated on the basis of 1957 data for 33 oil companies producing and processing about half the world's oil. (See Chase Manhattan Bank's Annual Financial Analysis of the Petroleum Industry, 1957.)

7 to 19 million barrels per day. Oil now provides 37 percent of the world's supply of commercial sources of energy.

**Estimated World Consumption of Commercial[1] Energy Sources in 1958**

| | Quantity (Btu x $10^{15}$) | Percentage of Total |
|---|---|---|
| Petroleum Products[2] | 40 | 37 |
| Natural Gas | 13 | 12 |
| Coal & Lignite | 53 | 49 |
| Water Power[3] | 2 | 2 |
| TOTAL | 108 | 100 |

[1] Non-commercial fuels (chiefly wood, peat and bagasse) currently contribute an estimated 12 x $10^{15}$ Btu to world energy supplies.
[2] Including non-fuel products.
[3] True heat value.

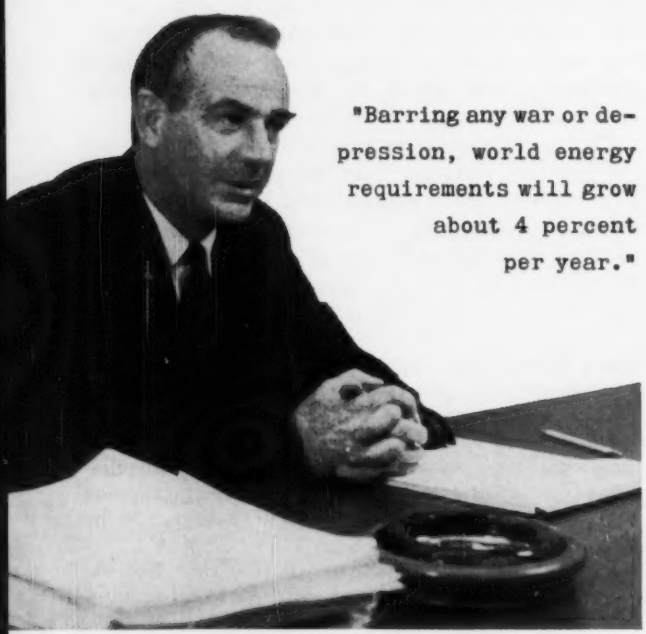
Petroleum has attained its present position, in part by displacing other sources of energy, but chiefly by virtue of:

**1.** Growth in the world's total energy requirements.

**2.** Oil's technical or economic advantages over other sources of energy in certain uses and in certain places.

### BY 1984

The world's total energy requirements will certainly increase during the next 25 years. If these years see a repetition of the conditions that existed between 1913 and 1958, when economic development was interrupted for long periods by war and depression, requirements will increase at a rate of only about 2 percent a year. In war-free, depression-free periods, however, energy requirements have grown consistently at a rate of about 4.5 percent yearly, in spite of very substantial gains in fuel efficiency.



"Barring any war or depression, world energy requirements will grow about 4 percent per year."

**Average Annual Rates of Increase in World Production of Commercial Sources of Energy 1860-1957**

| | (Percentages) |
|---|---|
| 1860-1870 | 4.4 |
| 1870-1880 | 4.6 |
| 1880-1890 | 4.5 |
| 1890-1900 | 4.1 |
| 1900-1910 | 4.4 |
| 1860-1913 | 4.4 |
| 1921-1929 | 4.8* |
| 1932-1939 | 5.1 |
| 1950-1958 | 4.6** |

* The 1919-1929 rate averaged only 3.9% per year.
** The 1946-1957 rate averaged 5.3% per year, but included the main period of reconstruction.

In the light of these figures, it seems reasonable to suppose that, barring war or depression, the world's energy requirements will continue to grow at a rate of somewhere around four percent per year for the next 25 years. At this rate, they would amount to about 285 x $10^{15}$ Btu per year by 1984, and cummulative requirements between now and 1984 would total 4.5 $Q$ ($Q = 10^{18}$ Btu.)

How will these requirements be met?

World reserves of the several sources of energy are sufficient to meet any calls that may be made upon them for much longer than the next 25 years. Coal reserves total something more than 5 trillion tons; total reserves of liquid petroleum are estimated by Weeks[1] at around 1.5 trillion barrels, and an equal quantity of oil may be obtainable from shales and tar sands; and natural gas reserves have been estimated by Weeks at 5 to 6 trillion Mcf. Together, these reserves have an energy content of about 168 $Q$, distributed as follows:

- Coal & Lignite 145
- Petroleum 8.7
- Oil Shales and Sands 8.7+
- Natural Gas 5 to 6

**Other Sources.** This makes it quite clear that the reserve of any one of the sources shown is large enough by itself to meet all the world's energy requirements between now and 1984, if necessary. Moreover, substantial additional supplies of energy are available in the form of water power (potential output per annum estimated at 14 x $10^{12}$ Btu.) or are potentially obtainable from the sun, the wind, the tides, volcanic steam, and nuclear fuels. The question is therefore one of selection, and the answer to it will be determined largely by technical and economic factors.

Technical factors, for example, are likely to *require* the use of particular energy sources for certain purposes: coal for the production of metallurgical coke; oil for air and highway transportation, for agriculture and for lubri-

"World oil consumption should be about 55 million barrels daily by 1984."

cation; and electricity for lighting, refrigeration, air conditioning, power and electro-processing.

In 1955, coal fed to coke ovens represented 10 percent of the world's total energy supply; oil consumed for the purposes listed above represented about 13 percent of the total, and electricity 2 percent of the total. Altogether, a quarter of the world's energy demand was based largely on technical factors.

Technical factors will also *limit* use of certain energy sources. For example, the minimum size requirement and the radiation hazards of nuclear fuels are likely to bar them, for many years, from use in automotive vehicles and small establishments.

Economic factors will steer the selection of energy sources toward those that are economically most attractive—not only in terms of relative prices, but also according to their availability from domestic sources. Thus, many countries will make some use of relatively expensive, domestically produced coal, oil, or nuclear energy rather than lower cost imported energy in order to avoid additional burdens on their limited foreign exchange reserves.

**Cost Factors.** It is probably safe to assume that the costs of all sources of energy will rise in future. It is almost as safe to assume that they will rise unequally—as they have in the past—mainly because of differences in the ratios of labor costs to total costs of production and distribution.

Electricity costs are likely to rise relatively slowly, not only because their labor component is small, but also because of prospective gains in the fuel efficiency of thermal electric power plants. Gas and oil costs should rise somewhat more rapidly, but here costs may be held back by the discovery and development of new resources and by the development of better means of transportation—large diameter pipelines operated at higher pressures, and larger tankers.

Coal costs, with the large labor component, are likely to rise relatively rapidly unless there are revolutionary increases in the productivity of coal miners, especially outside the United States. The costs of nuclear energy, on the other hand, are expected to decline rather substantially during the next 25 years.

**Nuclear Use.** It is impossible to weigh the potential effects of these technical and economic factors at all precisely, especially with so much uncertainty concerning the rate at which the costs of nuclear energy will approach competitive levels in various activities and in various parts of the world.

The evidence available at the present time indicates that nuclear energy will make only a very small contribution to the world's energy supply for at least ten, and more probably 15 years. It also indicates that, in the latter years of the period under review, nuclear fuel may displace some oil, especially in shipping, but its main function will be to take the place of hydro-electric power* and high-priced coal.

This prospect could be altered drastically by unforeseen developments in nuclear technology. As of the present moment, however, it appears that, in the world as a whole, the next 25 years will be good years for all the energy industries and will include at least 15 years of exceptional growth for the petroleum industry.

Petroleum will lose some of its actual or potential markets in areas where natural gas is available. It may also lose certain markets—such as the bunker market—to nuclear fuels. But these losses will be more than offset by gains in areas where coal has become relatively expensive, and by the growth of oil's basic technical markets. Unless the world economy is disrupted by major wars or depressions, world oil consumption should pass

* By 1975 most of the economically attractive water power sites of the major energy consuming countries will be already developed if present trends continue.

**About the Author**

**Nathaniel B. Guyol** is an economist for Standard Oil Co. of Calif. at San Francisco. A native of Concord, N.H., he attended the United States Naval Academy from 1926-28. He then went to the University of Chicago from 1929-31, where he Graduated with a B.S. degree in geography. He continued intermittently at the University until 1936, when he received his M.S. degree in geography. Guyol also took a summer course at Massachusetts Institute of Technology in 1940. He was with the Tennessee Valley Authority from 1935-42 as a geographer and regional planner, and with the United States Department of State from 1942-47 as an economist and geographer. He joined the United Nations Assembly staff in 1947 as an economist and statistician. In 1956 he joined Standard of California.

the 40 million-bpd mark well before 1975, and by 1984, should total somewhere around 55 million barrels daily.

**World Use.** A foray into the realm of pure conjecture suggests that, in 1984, world energy requirements might be satisfied somewhat as follows:

**Possible Structure of World Energy Supplies in 1984**

| | Quantity Btu x $10^{15}$ | Percentage of Total |
|---|---|---|
| Petroleum (& shale oil) | 115 | 40 |
| Natural gas | 45 | 16 |
| Coal and Lignite | 80 | 28 |
| Nuclear* | 40 | 14 |
| Other** | 5 | 2 |
| Total | 285 | 100 |

* Fuel input value.
** Hydro, solar, exotic fuels and other new sources of energy.

This is the pattern that seems most plausible at this time in the light of current technological and economic trends. It could be substantially altered by political factors such as tariffs, taxes and other restrictions on the free flow of oil from those who have it to those who need it.

**Energy values of Selected Fuels and Electricity***

| Commodity | Unit | Heat Value Per Unit (btu x $10^6$) |
|---|---|---|
| Coal | Short ton | 25.918 |
| Lignite | Short ton | 8.640 |
| Peat | Short ton | 12.960 |
| Fuelwood | Cord | 17.28 |
| Bagasse (dry) | Short ton | 12.960 |
| Natural gas (wet) | Mcf | 1.079 |
| Natural gas (dry) | Mcf | 1.035 |
| Crude petroleum | bbl. | 5.792 |
| Natural gasoline | bbl. | 5.229 |
| LPG | bbl. | 4.055 |
| Electricity | mwh | 3.412 |

* These values have been adopted as appropriate for studies dealing with the world as a whole. Actual values vary considerably from one area to another, especially the values of lignites, crude petroleum and natural gas.

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# Nuclear Energy

## Ship propulsion and process heat show promise for adoption of this form of energy which will account for about ten percent of the world energy supply during the next 25 years

**Ashton J. O'Donnell**
Stanford Research Institute, Menlo Park, Calif.

NUCLEAR FUELS will soon be supplying competitive power in some—but by no means all of the industrialized nations of the world. The Second International Conference on the Peaceful Uses of the Atom supported the conclusion that nuclear power from fission will compete favoraby with other forms of energy in many of the nations of Western Europe within five years. The same conference made it quite clear that power from fusion need not be considered an economic reality during the period, 1959-1984.

Most nations at the conference presented their plans for installation of power generating stations utilizing nuclear fuels. Few nations projected these plans beyond 1975; consequently, it has been necessary to extend their projections to arrive at a plausible figure for 1984.

The most ambitious single program has been initiated by Great Britain. It is destined to supply between 5,000 and 6,000 megawatts of electricity by 1966. An additional 4,000 megawatts is anticipated for the balance of Western Europe by that time. Canada, Japan and the United States will constitute the major additional nuclear capacity by 1966.

**Manpower Needs.** At the present stage of technology, nuclear power plants are economically attractive in stations where they can be operated as base load plants with load factors of 75 percent and higher, and in units of at least 100,000 electrical kilowatts. The high capital cost and the demand for trained scientists, engineers, and technicians places nuclear power out of the reach of a major segment of the world's population. Consequently, the projected use of nuclear power assumes that only approximately five percent of the total nuclear fuels by 1983 will be used in these countries.

Two major areas have been excluded from the forecast; namely, the U.S.S.R. and Red China. The Soviets have stated nothing regarding their plans for installation of nuclear powered electric generating stations. If an active nuclear power program is undertaken by these nations, the projected world nuclear fuel demand may increase by 30 to 50 percent over that shown in the chart for the period 1975 to 1984.

Two other applications for nuclear power should show

promise for wide adoption by 1984—ship propulsion and process heat. These applications are assumed to take on significant aspects after 1965.

For this study the thermal efficiency is assumed to increase from 25 percent in 1960 to 30 percent from 1965 to 1975, to 33 percent by 1984. A load factor of 80 percent is assumed in all cases. On the basis of these projections, the following figures were derived:

| | $Q$ per Year |
|---|---|
| 1960 | $5.7 \times 10^{-5}$ |
| 1965 | $1.1 \times 10^{-3}$ |
| 1975 | $7.9 \times 10^{-3}$ |
| 1984 | $3.4 \times 10^{-2}$ |

($Q = 10^{18}$ Btu)

Dr. Guyol uses the value of 0.040 $Q$ for 1984 as compared to the value here of 0.034 $Q$. We feel this is fairly good agreement. It is noted that by 1984 nuclear fuels will account for 10 percent of the energy supply assuming that Dr. Guyol's figure of 0.285 $Q$ per year is attained for total fuel consumption. In view of the early stage of development, the quantity of nuclear fuel consumed to date is considered insignificant and, therefore, the cumulative consumption for 1959 through 1984 is that represented by the curve—or approximately 0.35 $Q$.

# Shale Oil

**Declining cost of shale recovery along with increasing costs of oil exploration and production will change the shale vs. crude picture. Look for the trillion-barrel shale reserve to be used moderately**

**Fred L. Hartley**
Union Oil Company of California, Brea, Calif.

DR. GUYOL showed the anticipated increase in world energy requirements between 1860 and the year 1984. If these were extrapolated further we would see that the year 2010 requirements are about six times as great as 1950 requirements.

Considering only the U.S. energy requirements, Figure 1 shows our historic pattern, as well as predictions for the future. This chart reveals some basic questions about just which energy inputs will be called upon to satisfy

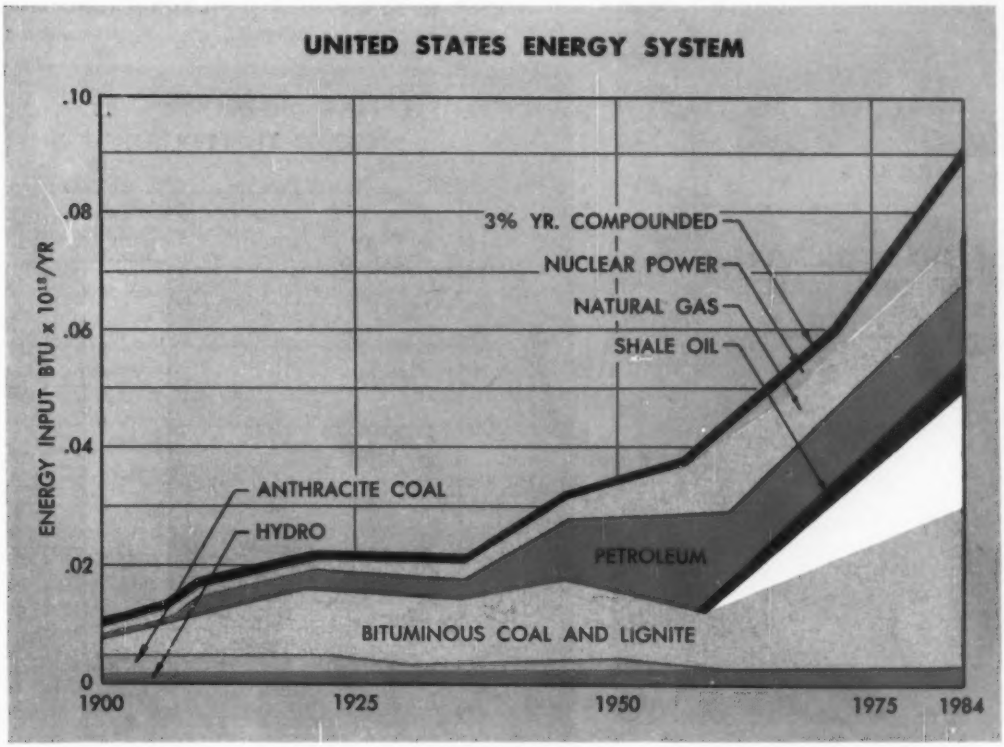



FIGURE 1

our requirements. The blank portion represents an area of decision to be resolved in an economic climate currently in its formative stages.

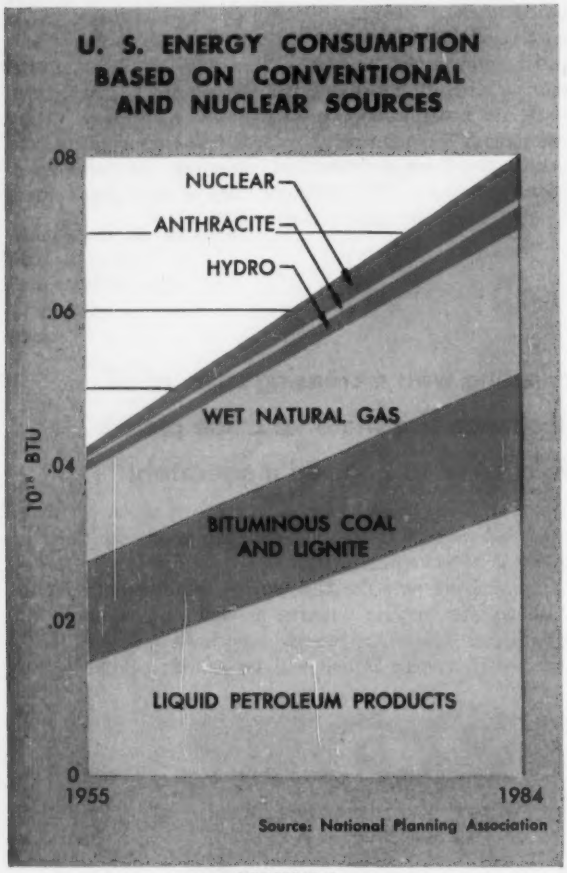



FIGURE 2

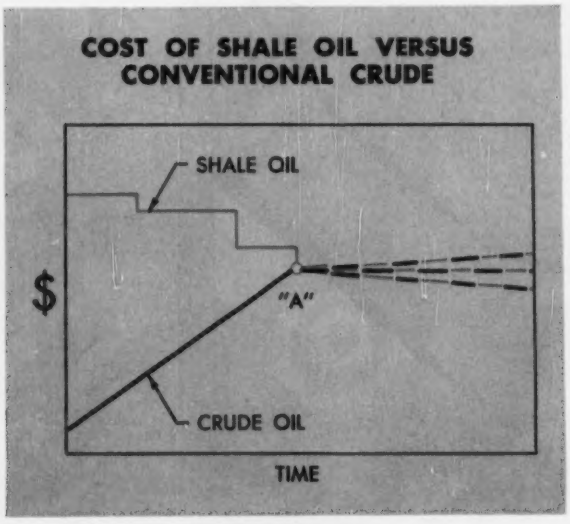



FIGURE 3

**Double Consumption.** In reviewing recent pronouncements on the subject of energy needs, and present and future energy sources, it is of interest to note a report describing the results of a pertinent study by Perry D. Teitelbaum, for the Special Policy Committee of the National Planning Association, published in July of last year. This study, concerning itself with U.S. energy requirements, predicts a doubling of U.S. energy consumption from 1958 to 1980.

It also predicts, in this study, that petroleum's share of the U.S. energy market will remain at about 40 percent. The tabulation shown in Figure 2, more a confidence factor than an exact prediction, estimates the impact of changes in the use of various forms of energy over the time period of the study shown.

In view, then, of these predicted increases in our requirements for liquid hydrocarbons, we next need to examine, more closely, factors of economic importance, such as, the increasing cost of recovering this energy source by conventional techniques. One example of these mounting costs is the increase in record well depths from 8,000 feet in 1928 to 23,000 in 1958. These greater depths involve increases in cost to the producer, which, of course, must be passed along into the market place.

**Economic Consideration.** From the standpoint of marketing the output of a future shale oil industry, Figure 3 illustrates a concept basic to shale oil versus domestic conventional crude cost (— price) considerations. Prior to convergence of the two costs curves, the cost of shale oil declines in fairly discrete steps reflecting technical

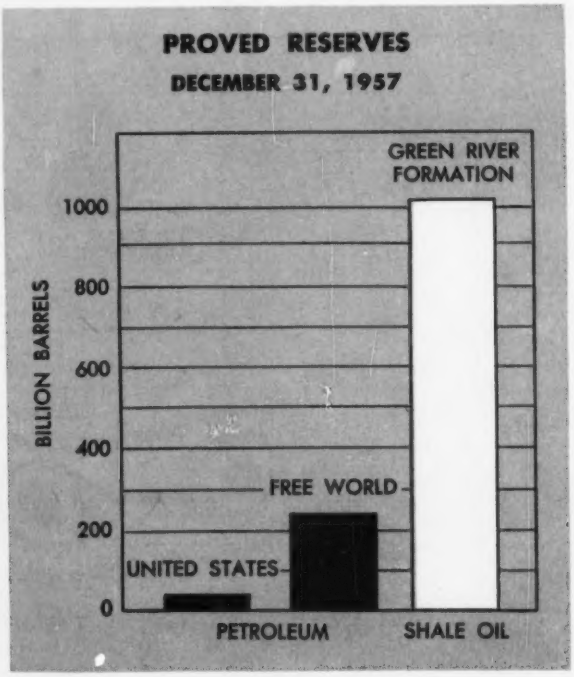



FIGURE 4

advances, while the cost of conventional crude oil steadily increases due to inevitably increasing costs of locating, drilling, and producing such oil.

At point "A" shale oil and conventional crude oil costs are essentially equal. This is, therefore, the point in time at which shale oil can enter the marketplace. As to the *exact* time that this will occur, we must recognize that the present price of crude oil, due to world-wide oversupply, is depressed to a point where it is impossible to determine just what a competitive price might be. Further, the production of a large amount of oil from this or any other locality, at this time, would only augment the present condition of oversupply. Nevertheless, because of our enormous demand for sources of energy, shale oil *will* take its place beside conventional crude oil, as an additional source to fulfill our needs.

Full-scale harnessing of the tremendous potential of our oil shale reserves, to augment conventional domestic production, would include utilization of the reserves shown in Figure 4, which compares United States and Free World, proved petroleum reserves (as of December 31, 1957) and the most recent U.S. Geological Survey estimate of shale oil reserves contained in the "Green River Formation." The indicated shale oil reserve of 1.1 trillion barrels is based on 75 percent rock recovery.

# Tar Sands

## Although very rapid advances will be made, only a relatively small percentage of the tremendous potential will be tapped as a source of energy by 1984

**G. W. Hodgson**
Research Council of Alberta, Calgary, Alta.

BEFORE LOOKING forward for 25 years in the future of the Athabasca oil sands, it is of interest to look backward briefly to see that the total production to date has been no more than about 50,000 barrels of oil.

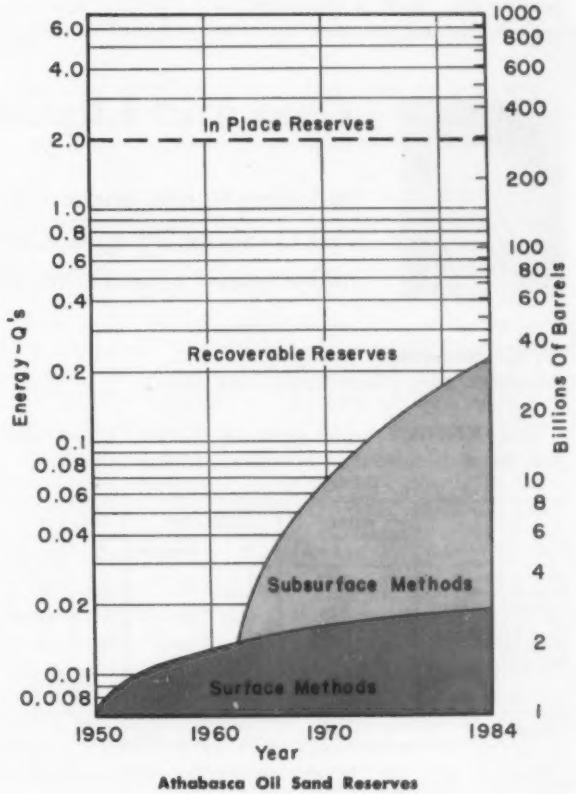
The energy reserve of the in-place oil underlying about 5,000 square miles of the Athabasca oil-sand deposit in northeastern Alberta, Canada, amounts to almost 2 *Q* units.

Production of crude oil from this reserve will be achieved by (a) surface mining methods and (b) methods based on in-situ combustion and miscible phase flooding. Surface mining methods involving separation plants are advanced to such an extent that the oil reserves under light overburden are almost immediately amenable to development, and it can be said therefore that about 1 percent of the total in place reserves—0.02 *Q* units—are the present economically recoverable reserves of the oil sands.

The rapid advance in the technology of subsurface secondary recovery methods and the steadily rising cost of finding crude oil are of vital concern in evaluating the position of the major portion of the oil sand reserve in the crude oil energy market.

**A Slow Rise.** The net effect will be a meeting of the total production costs, and the more competitive the Athabasca production becomes, the greater will become the recoverable reserves of Athabasca oil. In this manner the recoverable reserves of Athabasca oil will rise from the present 0.02 *Q* figure for the surface or mineable reserves toward the ultimate 2 *Q* limit. The rise will begin early in the 25-year period and might well reach the 10 percent point by the end of it, giving a recoverable energy reserve of 0.2 *Q* which is roughly equivalent to the ultimate reserve of conventional crude oil presently expected for the whole of Canada.

These figures assume that the Athabasca oil will be used solely for the production of energy. However, when the rapidly expanding market for petrochemicals demands it, some of the oil will be channeled into non-energy markets; but it seems difficult to believe that any appreciable fraction of the immense reserve will be utilized in




Athabasca Oil Sand Reserves

this manner prior to 1984, because the oil is not unique in chemical constitution.

Nevertheless, it is interesting to speculate on the market displacements that will occur ultimately quite apart from its position as sulfur or trace metal ore—in the general textile, construction, and metals markets.

# Gilsonite

**Although the present refining capacity will be increased to 1,000 tons a day feed rate, the big use may be in the chemical production rather than for fuel purposes**

**E. F. Goodner**
American Gilsonite Company, Salt Lake City

THE DEPOSITS of Gilsonite in the Bonanza, Utah, area total about 16 million tons of presently workable sized veins. There is probably another 10 million tons existing in narrower veins which, by the time they are needed, should be valuable enough to justify their production. There is probably another five or six million tons of Gilsonite in the Uintah Basin lying 40 or 50 miles west of Bonanza. This entire amount is equivalent to 0.001 *Q*.

Regarding consumption for fuel purposes, at the present time a refinery at Gilsonite, Colo., is consuming about 650 tons of gilsonite per calendar day producing high purity coke which is consumed as a reducing agent in various thermal processes and also consumed as anodes in the aluminum reduction industry. The other product from the refinery is gasoline, averaging about 1,300 barrels per calendar day.

This refinery will be enlarged within the next few years to an ultimate capacity of 1,000 tons per calendar day feed rate.

About 80,000 tons per year of Gilsonite are mined and sold without any chemical alteration to various industries which use it as an ingredient in compounded products, none of which consume it as a fuel.

The future of these deposits lies in the extraction of various components of the Gilsonite such as resins, asphaltenes and various nitrogen base compounds. These are very promising substances by themselves and a great many of them are readily combined to form adhesives, thermal setting compounds and for synthesis of organic complexes.

# Coal and Lignite

**Including lignite and peat, here is a tremendous reserve of almost 150 Q (about 26 trillion barrels of oil). If costs are right, this fuel will make heavy inroads into both the fuel and chemical industries**

**W. C. Schroeder**
University of Maryland, College Park, Md.

THE KNOWN world resources of coal, lignite, and peat are accumulated in five great areas as follows:

| PART OF WORLD | COAL* | | LIGNITE* | | PEAT*† | |
|---|---|---|---|---|---|---|
| | Q | Percent | Q | Percent | Q | Percent |
| Western Europe | 10 | 9 | 1.2 | 5 | 0.8 | 8 |
| Eastern Europe (Russia Excluded) | 2.4 | 2 | 0.25 | 1 | 2.6 | 25 |
| U.S.S.R. | 24 | 20 | 3.4 | 16 | 6.2 | 59 |
| Asia (Russia Excl.) | 26 | 22 | .... | .... | .... | .... |
| North America | 50 | 43 | 16 | 74 | 0.8 | 8 |
| Rest of World | 4.8 | 4 | 0.8 | 4 | .... | .... |
| | 117.2 | 100 | 21.65 | 100 | 10.4 | 100 |

Total: 149 Q
* Estimates based on Coal at 11,000 Btu/lb. Lignite at 8,000 Btu/lb. Peat at 4,000 Btu/lb.
†Basic data for the above table taken from *Coal Science*, D. W. Van Krevelen and J. Schuyer, Elsevier Publishing Co.

Dr. Guyol's estimate includes allowance for mining recovery, losses in extraction and several other factors. The above estimates, on the other hand, are for reserves only and the matter of loss in recovery and loss in utilization has been left out of these figures. This is desirable because both percentage recovery and the amount of heat recovered in utilization may increase considerably as time goes on.

It must be remembered, however, that not all of the coal is recovered in the mining process. In underground mining recovery is usually in the order of 50 to 60 percent. In strip mining, recovery can be in the order of 90 percent and above where conditions are favorable. Even allowing for losses, however, it is apparent that these reserves are vastly greater than the known or potential reserves of liquid or gaseous fuels, and in fact are probably in the range of 20 to 30 times the other fuels.

**Ample Reserves.** The United States is especially well endowed with coal and lignite with the known reserves amounting to about 66 *Q*. This is considerably more than any other country in the world, but these reserves may, in part, represent the results of more concentrated exploratory work in the U.S. as compared to Soviet Russia, for example.

Current world production of coal and lignite is estimated as follows:

| PART OF WORLD | Coal Q | Lignite Q |
|---|---|---|
| North America | 0.013 | 0.0001 |
| Western Europe | 0.011 | 0.0048 |
| Eastern Europe | 0.002 | |
| U.S.S.R. | 0.006 | |
| Asia Far East | 0.003 | |
| Rest of World | 0.001 | 0.0003 |
| Total | 0.036 | 0.0052 |

From these estimates it is apparent that the production of coal and lignite even in the highly industrialized countries is small compared to the available reserves. Even with allowance for growing populations and vastly increased uses, coal reserves should last for generations, and very probably for centuries.

During and shortly after World War II production of coal hit a peak of slightly over 600 million tons. Since that time production has fallen and for 1958 it is estimated that production will amount to about 420 million tons.

On the basis of a national or world conservation policy it would obviously be desirable to shift a greater portion of the energy load from oil and gas to coal. In the U.S. the opportunities for doing this are growing because coal is becoming a comparatively cheaper raw material. A major shift in the burden may depend, however, on the conversion of the coal to a more convenient liquid or gaseous form.

The technology of this conversion is well known, but the economics have not been favorable up to the present time in the United States. Now that coal is in a more favorable competitive position with respect to raw material prices, the major factor that stands in the way of conversion to oil is the capital cost of the conversion plant. It is quite possible that the next few years will see the development of new technology which may solve this problem.

# Solar Energy

**An oil well on a quarter section of land would have to yield 2,500 barrels daily perpetually to equal the solar energy received on that piece of ground**

**George O. G. Lof**
Denver

THE UNIVERSAL AVAILABILITY and the great abundance of solar energy makes this a tempting supply for the future. The energy being received from the sun is about 1,700 times as much as our total U.S. energy consumption. This abundance can be visualized by a simple comparison which shows that an oil well on a quarter section of land would have to yield 2,500 barrels daily perpetually to have an energy output equal to the solar energy being received on that piece of ground.

Solar has of course been used for salt production by sea-water evaporation, for the drying of crops, and, during this century, for water heating in parts of California and Florida. It has been estimated that about 25,000 solar water heaters are in use. One of these heaters can recover about 15 million Btu per year, and the total estimated number of units would supply about $4 \times 10^{11}$ Btu per year. Thus, excluding crop drying and sea-salt production, present "artificial" use of solar energy in this country is about $4 \times 10^{-7}$ *Q*. In the world, perhaps double this figure might be utilized now or in the near future.

**Await Equipment.** It is in the house heating and cooling applications, however, that the major solar energy possibility during the next 25 years exists. Estimates of heat recovery by this method are difficult at this time because substantial entry of solar heating into the domestic field must await entry of manufacturers into the production and sale of solar heat exchange equipment.

Assuming that thoroughly practical, factory-built solar heat exchangers will be available in volume within the next ten years, and assuming that within 25 years, the annual installation of solar heating equipment and solar air conditioning units will be at least ten percent of all new domestic heating and cooling installations, 400,000 solar homes might be in operation by 1984. These installations, along with solar water heaters, might be expected to supply about $10^{14}$ Btu's per year, or 0.0001 *Q*. Cumulative solar energy recovery for house heating and cooling through 1984 could be, on the basis of these estimates, perhaps 0.001 *Q*.

In summary, the plausible energy input from non-biological solar conversion, in applications principally associated with residential heating, cooling, and water heating, should be about 0.0001 *Q* per year by 1984 in the United States and the total cumulative energy use in this way by the year 1984 might approach 0.001 *Q*. Slower development and application of this energy in other parts of the world might be largely offset by higher fuel costs and greater energy needs in many areas. As a very rough estimate, we might visualize total solar energy conversion in the rest of the world two to four times that in the United States. Total annual world input of 0.0003 *Q* to 0.0005 *Q* could thus be conceived.

# High Energy Fuels

**These are specialty fuels and will not invade any of the present energy markets. In fact, this industry may become strongly dependent on petroleum and petrochemicals**

**W. R. Millard**
Callery Chemical Company, Callery, Penn.

THE VALUE of hydrocarbon fuels is probably best appreciated by the chemist involved in synthesizing new fuels. Of all the elements, only hydrogen, beryllium, and boron release more energy per unit weight on combustion than carbon. There is also a possibility that lithium, magnesium and aluminum can be used to synthesize fuels more energetic than hydrocarbons. Despite the limited possibilities, appreciable progress has been made in developing fuels exhibiting significant improvement in thermal energy release.

One class of compounds receiving considerable publicity consists of the boranes. Pentaborane ($B_5H_9$) for example, has a heat of combustion of about 29,000 Btu per pound. This is about 57 percent higher than the heat released by JP-4. More important, pentaborane completely burned with stoichiometric air releases nearly 80 percent more heat per pound of fuel plus air than does JP-4. It appears that future objectives for both air-breathing engines and rocket missiles require improved propulsion systems. The inherent limitations of heat engines suggest that major improvements in propulsion must come to a large extent through improved fuels.

**High Cost.** As in the case of any material used as a fuel, the quantities of "exotic" fuels required for most applications are significant. In the case of non-hydrocarbon fuels, however, the inherent cost of the compounds appears significantly greater than that of such fuels as JP-4. It appears unlikely that fuels offering a significant improvement over hydrocarbons can be manufactured for less than approximately $1 a pound, although costs as low as $1 a gallon have been forecast.

As a result, it is highly probable that the application of such fuels will be limited to situations in which incremental performance pays appreciable dividends. With the increasing complexity and resulting costs of new weapons systems, the cost of fuel becomes less significant. This is particularly true of one-trip systems such as rocket missiles. For such applications, high energy fuels, therefore, appear to be economically justified.

One optimistic forecast of the future potential of the high energy fuels predicts a billion dollar a year business in less than a decade; most experts are more conservative.

The manufacture of high energy fuels may become strongly dependent on the petroleum and petrochemical industries. There appears little doubt that the high energy fuels will require hydrogen in their syntheses; petroleum would appear to be an excellent source of low-cost hydrogen. Many of the presently proposed high energy fuels may contain alkyl groups or carbon skeletons. Examples are the alkyl borons and aluminums.

It appears that the petroleum industry has a potential stake in the high energy fuel field, and there is increasing evidence of the industry's interest. Gulf Oil Company has a part interest in Callery Chemical Company, a pioneer in the field. Phillips Chemical Company has been engaged in the propellant field for several years. Standard Oil Company (Indiana) recently declared itself in the game. Increasing participation of the petroleum industry can be expected.

# Miscellaneous Energy

**Here are a dozen other forms of energy and although they will increase three-fold by 1984, they will still account for only 1.5 percent of the total energy used**

**John J. McKetta**
The University of Texas, Austin

THE FOREGOING fuels will account for approximately 98.5 percent of the energy sources in 1984. Other sources of energy will consist of water power, wood, wind, wave energy, fuel cells and others. In this group the dark horse to watch is the fuel cell.

**Fuel Cells.** Fuel cells are electrochemical devices for changing the heat of combustion into electrical energy. Of the several types, the hydrogen-oxygen cells operate in the range of 0-250 C. and at any pressures up to 50 atmospheres. These have limited use for power source because of the expense of the oxygen. The second type, called the high temperature cell, operates at 500-850 C. and uses air instead of oxygen.

The U.S. Bureau of Mines at Library, Penn., report a cell voltage of 0.75 at a current density of 35 amps per square foot (apsf). A practical fuel cell should have a current density of at least 200 apsf. Others report work with hydrocarbons as the source of hydrogen with a current density of three or four times that of the U.S. Bureau of Mines. Presently the life of a fuel cell is reported at approximately six months which is much too low for industrial use. This compares extremely well with the average 30 percent conversion efficiency obtained in the steam plants.

It is anticipated that the fuel cell will be ultimately about one cubic foot in size, will produce one KWH electrical energy from about 12 cubic feet of oxygen and 24 cubic feet of hydrogen. Be prepared to find one of these in your small auto in the near future, on your lawnmower, and on your outboard motor.

**Free Radicals.** Free radicals are uncharged, unstable fragments of molecules. There will be much more work required in the separation and concentration of free radicals before a significant amount of energy will be obtained from this source for industrial purposes. In fact there is the possibility that metastable radicals or states will be a more important source of energy than the free radicals.

**Water Power.** At the present time water power produces about one percent of the world energy output. The world hydroelectric potential is not more than approximately ten times the present capacity. Therefore, only a small increase in this form of energy is envisioned for the next 25 years.

Miscellaneous Energy Sources
(annual consumption)
($Q = 10^{18}$ Btu)

| SOURCE | 1958 | 1984 |
|---|---|---|
| Wood | 0.0010 | 0.0015 |
| Water Power (Dams) | 0.0008 | 0.0015 |
| Farm Wastes | 0.0001 | 0.0005 |
| Wind Power | 0.0001 | 0.0002 |
| Temp. Diff. Tropical Waters | 0.0000 | 0.0001 |
| Tides | 0.0000 | 0.0001 |
| Earth's Heat (Volcanic, etc.) | 0.0000 | 0.0005 |
| Fuel Cells | 0.0000 | 0.0010 |
| Wave Motion | 0.0000 | 0.0001 |
| Free Radicals | 0.0000 | 0.0000 |
| Atmospheric Electricity | 0.0000 | 0.0000 |
| Controlled Biological Synthesis | 0.0000 | 0.0000 |
| Total | 0.0020 | 0.0055 |

The miscellaneous sources of energy will increase about three fold in the next 25 years. Although the actual amount of miscellaneous energy seems small, the 1985 total of 0.0055 will amount to approximately two percent of the total energy source, which is a significant amount.

# THE AUTHORS

**ASHTON J. O'DONNELL** is manager of program development for Standard Research Institute, Menlo Park, Calif., where he develops and coordinates the Institute's research programs. After receiving a B.S. degree in physics from Whitman College in 1943, he worked as a physicist at the University of California Radiation laboratory, later transferring to the uranium-235 electromagnetic separations plant, Oak Ridge, Tenn. O'Donnell has been with the U.S. Atomic Energy Commission as director, Technical Operations Division, and with the Institute as manager of nuclear economics research and nuclear developments.

**FRED L. HARTLEY** is vice president of research for Union Oil Company of Calif.'s Union Research center, Brea, Calif. He received a B.S. degree in chemical engineering from the University of British Columbia and joined Union Oil in 1939. From 1942-50 he was manufacturing process supervisor—then became general superintendent of Union's Los Angeles refinery. In 1953 Hartley transferred to the Research department, Commercial Development division, and in 1955 became general manager, Research department. He was elected a vice president in 1956. Hartley is a former president of CNGA and is still a director and member of its executive committee.

**DR. G. W. HODGSON** is head of petroleum research for the Research Council of Alberta (Canada). His fundamental duty is to lead studies on petroleum research. Dr. Hodgson received a B.S. degree in chemistry in 1946, and a M.S. degree in chemistry in 1947, both from the University of Alberta. He then earned a Ph.D. degree in physical chemistry from McGill University, Montreal, in 1949, and began his career at the Bitumount oil sand separation plant the same year. He then spent eight years with the Research Council on Petroleum Research, dealing mainly with origin and accumulation and pipelining. He became the petroleum research head last April.

# THE AUTHORS

**ERNEST F. GOODNER** is the president of American Gilsonite Co., Salt Lake City. He attended the University of Washington, where he graduated with a B.S. degree in chemical engineering. He then attended the University's graduate school and received a M.S. degree in ceramics. Since 1921, Goodner has been practicing ceramic engineering and chemical engineering. His work has been primarily in the fields of design, construction and operation of plants—mostly those which manufacture calcium carbide, terra cotta, and refractories. He has also dealt with various petroleum refining facilities. Since 1948, Goodner has been concerned entirely with the operations American Gilsonite.

**DR. W. C. SCHROEDER** is a professor of chemical engineering at the University of Maryland, and a consulting engineer. He has B.S., M.S., and Ph.D. degrees in chemical engineering from the University of Michigan. From 1934-38, Dr. Schroeder led research for ASME on high-temperature corrosion and from 1939-44 was with the U.S. Bureau of Mines, Fuels and Explosives branch, developing oil and gasoline processes from coal and other solid fuels. He was assistant chief of the branch from 1943-44. In 1945 he became chief of the Office of Synthetic Liquid Fuels, and assumed his professorship at Maryland in 1953.

**DR. GEORGE O. G. LOF** is a part-time research associate for the University of Wisconsin and for Resources for the Future. He is also a consulting chemical engineer in Denver, Colo., on research and development in solar energy and water resoures. Dr. Löf received a B.S. degree from the University of Denver in 1935, and a D.Sc. degree from M.I.T. in 1940—then taught chemical engineering at the University of Colorado, 1940-47. He was technical director at Colorado Fuel and Iron Co.'s Denver chemical plant from 1947-48, and professor and chairman of chemical engineering and a director of the Institute of Industrial Research, University of Denver, 1948-52.

**DR. W. R. MILLARD** is manager of special projects for Callery Chemical Co., where he develops new areas for research and development. He has B.S. and M.S. degrees in chemical engineering from the University of Missouri, and a PhD. degree in chemical engineering from Cornell University. Dr. Millard joined Callery in 1954, and has been there ever since. Previously with Parke Thompson Associates from 1952-54, he was an assistant professor of chemical engineering at Iowa State College, and an associate engineer for Ames laboratory from 1950-52. He has also worked for Shell Oil Co., Hercules Powder Co., and the U.S. Army Chemical Warfare Service.

# CHEMICAL USE OF OIL MAY WANE

**J. A. Sherred**
Lion Oil Division, Monsanto Chemical Co., New Orleans

DURING THE past 10 or 20 years the synthetic organic chemical industry has grown at a rate of more than 10% per year and recent information indicates a continued growth at a rate only slightly less than this. Most of this growth has been derived from the rapidly expanding use of hydrocarbons derived from crude petroleum and natural gas so that today more than one-quarter of the volume and one-half of the dollar value of all chemicals produced are based on petroleum raw materials.

The reason for this rapidly increasing use of petroleum is twofold: the older aromatic chemical industry was based on coal-tar produced as a by-product in coke manufacture. When supplies from this source failed to satisfy their needs, chemical manufacturers turned to petroleum refiners for their aromatic raw materials and thereby brought into being the large petroleum aromatics (benzene, toluene and xylenes) industry that exists today. In the more recent aliphatic chemical industry, economics rather than supply factors played a more important role. Use of petroleum raw materials showed definite cost advantages over use of coal or agricultural products.

There seems to be no reason to assume that this trend toward even greater dependence on crude oil and natural gas will not continue for at least the next decade.

However, in a longer range projection these optimistic forecasts should be accepted only with considerable reservation.

**Plenty Raw Material.** Even if all chemicals expected to be produced in the U.S. in 1984 were derived from petroleum sources, this industry would still use less than 10% of the total crude petroleum and natural gas demand anticipated at that time. A more realistic appraisal would indicate a 5 to 6% usage. This shows quite clearly that the chemical industry need have no fears regarding the physical availability of the needed raw materials.

On the other hand we must expect that the value of these raw materials in the energy market will control the prices at which they will be available for chemical usage. Changes in the energy market will thus have a direct bearing on chemical raw material prices and the extent of the chemical industry's reliance on petroleum.

One of the strengths of the chemical industry is its wide diversification and flexibility. At the same time this presents real difficulties in attempting to generalize. Few chemical products are uniquely tied to a particular raw material. Most chemical producers have a wide choice of raw materials and processing techniques at their disposal, even for manufacture of the same end-product. Certainly, the German chemical industry demonstrated during World War II a surprising ability to build an extensive and diversified chemical industry using coal exclusively as raw material. The Germans developed synthetic organic chemical processes that were highly successful from a technical standpoint. Given the proper relationship between the value of coal and petroleum hydrocarbons in the energy market, this could happen here. As a specific example, the value of natural gas as energy is rising at such a rate that new facilities for manufacturing synthetic ammonia are expected to change from gas to coal or heavy fuel as raw material. This will probably come within the next decade.

A similar change is expected in the synthesis of methanol. There are no factors, other than economics, that will prevent a large number of present chemical products from being made from coal via calcium carbide and acetylene rather than from petroleum.

**Available By-Products.** Another facet of the energy industries that merits attention is the availability of by-products. We have already mentioned that, historically, the synthetic organic chemical industry was based on the use of coal-tar. This, in turn, was a by-product of coke or town-gas manufacture available at by-product prices but whose supply was limited by the demand for coke.

It is important to realize that while coal-tar aromatics are essentially by-products, virtually all petrochemical raw materials are hydrocarbons which have definite values as petroleum products in a crude or impure state. They have to be deliberately purified and refined to degrees unnecessary in making conventional fuel products. To this extent the petrochemical industry does not, except in few instances, process refinery "by-products." It provides, solely, an avenue of more profitable sale for some few hydrocarbons than the conventional energy markets afford.

**By 1984.** In attempting to predict the relationship between the chemical industry and the petroleum industry for as far in the future as 25 years it is prudent, there-

**About the Author**

**J. A. Sherred** is development director of Monsanto Chemical Co.'s Lion Oil Co. division, New Orleans, where he forecasts industry trends, develops new products, and makes preliminary evaluations of new processes. A chemistry graduate of Balliol College, Oxford University, he spent ten years with Shell Oil Co. groups in England and The Netherlands as a refinery technologist. Sherred joined Monsanto in 1947 as a process engineer, then became development director for the Texas division. After serving as research development director for the Plastics division, he assumed his present post in 1956.

fore, to examine what by-products may become available for chemical use as a result of changes in the energy industries excluding conventional petroleum production and refining.

It appears likely that by 1984, oil-shale processing will contribute to the energy supply. This will make available nitrogen, sulfur and perhaps oxygenated compounds on a by-product basis which will certainly be used to the fullest extent possible as chemical raw materials. Similarly we may expect large-scale production of methane from coal to augment our natural gas reserves. This, too, is likely to lead to the production of tars and other by-products susceptible to chemical use.

Commercialization of either of these ventures is dependent on economic factors far removed from the chemical industry yet which may have a pronounced effect on its raw material availability. To the extent that desired end-products may be manufactured more cheaply using these new by-products, the chemical industry will use them.

In sum, we can expect a growing use of petroleum based hydrocarbons by the chemical industry for at least the next decade but as these become more costly, the rate of growth may well be slowed by the inexorable laws of economics and before 1984 we may see a greater use of coal or its by-products or oil-shale as chemical raw materials.

## By 1984 . . .

# A TRAINING CHALLENGE

THE GREATEST change in the training field in the future will be in the training director himself.

To meet the tremendous economic and social changes this country is undergoing, the training director will have to mature and become better prepared to meet the challenge. He must develop a practical, workable training philosophy. This may sound strange to some and to others it will be down right frightening. But too many training directors have slipped into a comfortable complacency and have not begun to develop a basic philosophy. There is the tendency to only get the "know-how" and not to develop the sense of "know-why" or, in other words, the understanding of the inherent challenges of their jobs.

**Understand Men.** The basic philosophy, of course, is one regarding people. This philosophy should include the tremendous potential and greatness of the individual, but to develop this, the training director must study and understand the personality of people.

This is not easy and many will say, "What do you want me to be? A psychiatrist? I'm no psychiatrist and I don't want to be one!" It really doesn't matter what the director wants. Whether he likes it or not, he is dealing with personalities. And, whether he likes it or not, he should become a serious student of human nature and stop ignoring the problem.

**Which Role?** The training man must also determine the exact role he is to play in his company and what management expects of him. If management considers his job should be limited to classroom work, then he can prepare himself for that. However, if he is expected to assist management in dealing with those human problems which can be alleviated or resolved through training, then the training man will have a perception of a different sort of a role—one in which he serves as an arm of management exploring and appraising human problems of the organization and dealing with them through a wide variety of training techniques.

The future holds very little for the "classroom" training man. The emerging picture of the successful training man is: a staff assistor and advisor, accepted by line officials as a partner in problem solving, and sought as a counselor on employe education, motivation, and interpersonal relationships.

Employe training, especially on the managerial level is a relatively new and constantly changing field with concepts still loosely formed. No one expects the training man to know all of it, but what he has to know is ever increasing.

Nearly all people entering the training field have different backgrounds of preparation. This means that each must fill the gaps through self-development. Each must ask himself, "What do I need to know? If there are gaps in my knowledge, where might they be?"

**In All Programs.** In most organizations the training man is assigned to the personnel office. This is a logical arrangement because, if training is to be effective, it must be integrated into the over-all personnel program—particularly with the functions of recruitment, selection, promotion and employe relations. Since this is true, the training man of 1984 must have "industrial relations" knowledge.

Included would be, (a) methods of job analysis, (b) how to interpret or convey to line management pertinent findings of the behavior sciences relating to individual and group effectiveness, (c) the components of supervisory and managerial work, including work planning, methods, work simplification, delegation, instructing subordinates, and job relations, and (d) concepts and techniques in personnel administration.

This broad listing is not intended to be interpreted as being utopian, and no one reasonably expects any individual to be thoroughly informed in all these areas. But

the more the training man has of this knowledge, the better he can expect to meet the training challenges of the future.

**Better Mouse Trap.** Creativity is another attribute that the future training man must possess. To devise a formula which explains the structure of the universe . . . or to build a better mouse trap . . . both mark the creative man. Both show the power of mind that can envision an idea and, more important, develop the idea into a working force.

A corollary to creativity is a personality that will lead officials to come to the training man to discuss significant problems of the organization and the means of their possible solution. By personality, it is not meant the shining, glad-handing radiance of the professional extrovert, but rather the integrity and character in which another can place trust; also sound knowledge, analytical ability, flexibility and good judgment.

**Results.** One of the most difficult tasks that will face the training man within the next 25 years is the evaluation of his programs. Evaluation is one of the most difficult aspects in the design of a training program. Because it is difficult, training men have been putting forth a weak effort or not doing it at all. Even management has overlooked this aspect. But, no more. It is becoming more evident every day that management wants to know: Has this program met the training needs of the organization?

Where results can be measured, the problem of evaluation is relatively simple. However, the further removed the training is from manual or manipulative skills and the closer it approaches the functions of cognition, judgment and personal effectiveness, the more difficult it is to determine the existence of measurable relationships between training and its effects.

In appraising management training, however, the question the training man will be asked in the future is not whether training is effective, but rather how we determine whether it is or not: Is the method of evaluation itself valid?

The serious training man will recognize that training must be evaluated at different levels, and by so doing, it should be possible to improve the evaluative procedures and to get more accurate information about the effectiveness of his training programs.

**New Approach.** Management will not expect hard, quantitative proof immediately visible in the financial scoreboard of the organization. Nor will they expect complete objectivity and absolute certainty of success. For no evaluation techniques have yet been developed to provide this sort of objective proof.

They will ask, however, that a systematic approach be used that will determine the results of training in terms of its stated objectives. It should look for all reasonable evidence of both success and failure, provide for a system of cross checks, and seek an appraisal of data rather than an all or none answer.

For all training personnel, then, the years ahead should be fascinating because they offer so many challenges. The whole of management is in effect hoping for the training man's success, knowing full well that it can only operate efficiently in today's world-wide competition if trainers learn to develop, maintain and evaluate effective training programs and are willing to develop themselves.

No longer will training consist of rounding pegs to fit round holes, or of stuffing deficiencies like a dentist packs a tooth. Training is becoming a social activity in an economic milieu. The training man is in a very real sense in the front lines. He is on the verge of exciting discoveries and fascinating break-throughs. Only the future knows the secret of how he will stand and face the challenge.

## By 1984 . . .

# IN ENGINEERING EDUCATION– A DYNAMIC NEW CONCEPT

**John J. McKetta**
The University of Texas, Austin

IF YOU BOUGHT a new inner tube for your tire in 1913 and used it continuously, applying patches whenever necessary, the resultant patched-up inner tube (with patches on top of other patches) can be compared to the various present day patched-up engineering curricula. Before 1984 some brave dean from a large progressive eastern school will cast aside these old patched curricula and start with a brand new plan designed for present and future day purposes. This has to be started at a big eastern college, as no other smaller college administration will have the courage to permit its engineering dean to follow suit.

Twenty-five years from now operation and research problems will be along more fundamental bases than at

present. Each field will be concerned with combining applied basic science, economic consideration, and systematic organization of efforts. By this time, the electronic revolution will have reached an advanced state in transforming the world. The computors and data processing equipment will relieve man from many mental calculations while the continued progress in the automated equipment will relieve him of much of the physical efforts.

Newer discoveries will place atomic fission, atomic fusion and the orbiting satellites on the back pages of importance. The technological revolution has not yet started. The ceaseless efforts of the highly educated and creative men, whether in engineering, sciences or the arts, will result in undreamed of developments in science, medicine, engineering, humanities and other fields including every day life. These scientific developments of the future are infinite in number. Their achievement will be proportional to man's disciplined and responsible intelligence. Just as the health of this nation is in the hands of the physicians, so the future safety of this nation is in the hands of engineers.

The present engineering curricula are not adequate to meet the challenges of these future developments. Today, more than 25 percent of the graduating engineers go into research and development as compared with 9 percent ten years ago. By 1984 this figure will increase to more than 75 percent.

### WHAT WILL WE HAVE?

In order to discontinue the traditional divisions and curricula, the following requirements are mandatory:

1. Deans must have vision and courage
2. Administrators must give the deans a loose rope, encouragement and assistance
3. Industry, politicians and the people must keep hands off education and educators (although educators must admit that colleges probably would be still teaching only the classics if they were not prodded occasionally by industry and the people.)

Upon specific requests of deans and administrators, however, men of industry must be willing to promptly take active parts as educational advisors.

As for the student, not only must he be given basic courses and training but it is necessary that, when he graduates, he also have a practical point of view. Even the *research* engineer must have a practical point of view. This is, of course, the main difference between a scientist and engineer.

**Who Goes Where?** By 1984, we will have to be in the position where we can provide the best possible education for all young men and women who earnestly desire an education and who are sincere in wanting to learn. Too, this education would be pitched at the highest possible level which each of these boys and girls can absorb.

On the other hand, by this time it should be an established fact that a professional college education is not the automatic right of each high school graduate. It should be an earned privilege and only those who are selected through strict entrance examinations should be permitted to enter. This must be true even in the state colleges. This will exclude from professional colleges, most of those students who graduated from high school with below-average grades.

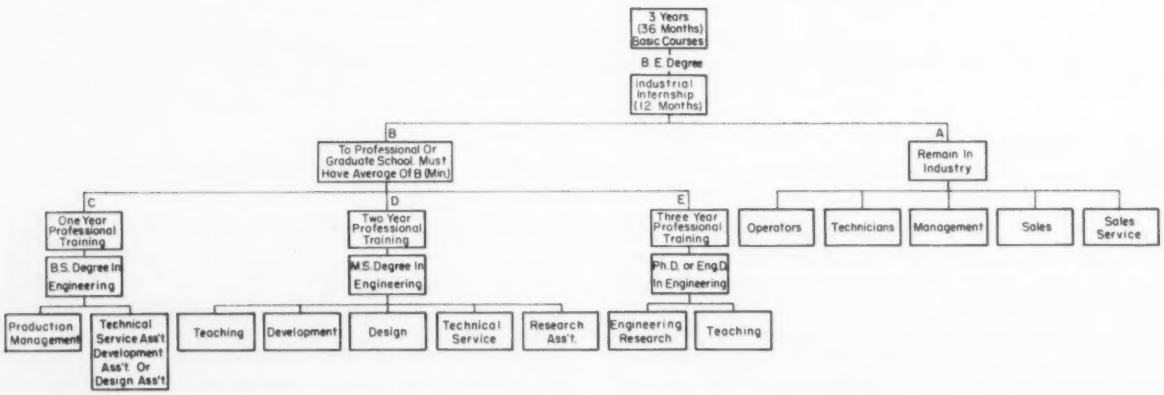
In addition, those who enter college for the "fun of it" and for "character building" should be discouraged from diluting the classes of the professional schools. Rather, there may be colleges with a more relaxed atmosphere for these students.

The universities will also give advanced standing examinations in most of the courses for those students who are able to pass certain courses without matriculation. The students will be expected to be serious in their pursuit of a professional education and will have rigorous schedules. They will all be supplied with scholarships so that they may concentrate on their studies.

**Students Must Learn.** The college will maintain absolute standards, under which a sub-standard student is dismissed no matter how great his efforts nor how high his entrance examination (or his IQ).

The universities have two purposes: teach the students to work and teach the students to think. Schools of higher

**FIGURE 1—Plan for professional training after industrial internship.**



learning cannot tolerate mediocrity in the students, the staff, the teaching, or in the research.

At the present time the university is the only place where a person puts his money on the counter and says "give me the least you can."

**Which Route?** After high school, the student has two choices: to work, or if he is capable, go to college. If he goes to work he must work five days a week, 12 months a year (with a two weeks vacation). There is no reason why college students should not spend the same amount of time in college—especially when scholarships will be available for tuition, books, food, room and board for all capable students. Therefore in 1984 there will be a 12 month school with three full years required for a basic degree.

After this 36-month period, the student will have a fundamental education upon which to base his professional practice. Was it not Peter Drucker who said so wisely, "A school can do a student no greater disservice than to prepare him for his first job."

But, industry must recognize that this student is not a specialist and industry cannot expect him to be one any more than we may expect an individual to be an accomplished brain surgeon after 36 months of pre-medical school. Industry can, however, expect and demand a basically trained man. The specialization will come from further work in professional or graduate school, or from industry which may give its own special training as it finds necessary.

**The Courses to Cut.** The present courses in the engineering colleges dealing with methods of maintenance, operation, technology, and cook-book courses will be omitted. The engineering college of 1984 will not contain a foundry, cupolas, or processing laboratories. Nor will the courses include plumbing, welding, manufacturing processes, wiring, and surveying. These must be covered by industry in specialized training courses or in private technical schools separate from the universities.

Mechanical drawing and descriptive geometry will be cut to a minimum (possibly a single two-hour course) and no college credit will be given for the usual high school type of courses such as algebra, trigonometry, geometry, English composition and elementary languages. These are too expensive to be repeated at the college level.

There is a very strong possibility that eventually the universities will begin to realize what industry has known for many years; that various engineering divisions lose their identity in industry. In industry there is little or no distinction between the mechanical, electrical, chemical or other engineers. In fact today is the time to begin questioning ourselves about such fields as food engineering, plastics engineering, nuclear engineering, resin engineering, paint engineering, fertilizer engineering etc.

**How About Labs?** Hardware laboratories will be eliminated. Laboratory work should be designed to illustrate fundamental application of scientific theory taught in the class room. Cook book chemistry, fuel analyses, and many of the mechanical, electrical and civil laboratories will be eliminated. The laboratory will be used to explore a problem, to integrate ideas from the classroom and to relate the basic methods of solving problems and arriving at a solution.

## THE FUTURE CURRICULA

**Many Plans.** There is no one curriculum which will be satisfactory for each college of engineering. Each school will have a different plan for educating engineers, hence a different curriculum. The accrediting committees will not like this idea for this sort of situation will make evaluation of curricula quite difficult. However, if we are to meet the tremendous needs of the industry of 1984 we must depart even further from tradition.

In addition to a basic education in the science and engineering subjects, the student of 1984 will be better trained in the classics and humanities. He must also be able to communicate with his coworkers and superiors in industry and therefore must be extremely competent in public speaking (even debating) and technical writing.

The basic engineering curriculum will be based on the stress of the "why" rather than the "how" of engineering. A young man with this sort of background will be able to shift more easily from one technical field to another, and to view complex problems more capably. For example, theories developed some time ago to explain the behavior of sun spots, and applied later by astrophysicists to study cosmic nubulae are now finding application to help solve problems relating to the control of thermonuclear energy (from atomic fusion), propulsion of space vehicles, shock waves, and hypersonic flight.

One type of curriculum may have the following content:

- 15 per cent mathematics.
- 15 per cent physics.
- 15 per cent chemistry.
- 20 per cent major interest and minor interest.
- 35 per cent free electives in humanities, etc.

**Possible Programs.** There are many programs which may be followed by 1984 and very few will be similar to the present day curricula. Here for instance are a few methods already being considered:

**1.** The chemical engineering department of The University of Texas and the University of Illinois have taken cognizance of the different desires and capabilities of the student at the end of the present sophomore year. Those who plan to obtain a B.S. degree and enter industry are taken through an engineering option route. Those more capable students who may plan to enter graduate school are placed into a *physical science* option route. There are many variations of this sort of planning, but generally this program is still based on the present type of curriculum.

**2.** Several schools are adopting an engineering science plan. Much has already been written about this.

Here are a few which may be considered by 1984:

**1.** A school of engineering could be split into two en-

tirely different branches; one for operation and production men, another for research and development men. The various state schools (or even neighboring states) could cooperate on such plans with one of these schools in each state.

**2.** Kirkbride[1] in 1947 suggested a basic curriculum within the engineering college as follows: (although this book is primarily for chemical engineers the program would fit a wide variety of engineers.)

- Material balances
- Energy balances
- Static equilibrium or considerations
- Dynamic equilibria or considerations
- Economic considerations.

**3.** A plan whereby the engineering college is divided into three departments instead of the present chemical, mechanical, civil, petroleum production, electrical, etc. This plan makes use of a three-department college; energy department, materials department, man department. Under the "man" department would be management, industrial engineering, operations research, business law, human relations, etc. The student would take a major in one of the three departments and a minor in a second department. For example a major in thermodynamics and a minor in man, or a major in electronics and a minor in metals, etc. A common core of mathematics, chemistry, physics, and applied mechanics would be taken.

**4.** The professional school such as the school of medicine or law. This is shown in Figure 1 and there are a great many modifications and possibilities of this method. In general the student receives three full years of basic training (36 months with no 3-month break in the summer) after which time he receives a B.E. (bachelor of engineering) degree. He then serves an industrial internship of 12 months (or possibly 24 months). If he desires to go into the field of management, operation supervision, sales, sales service or to remain as a technician he can remain in industry with no further formal college training. This is route A in Figure 1.

**Three Routes.** If the student, after his industrial internship, desires to enter the fields of production management or technical service assistantship, he will be able to return to a professional school (or graduate school) providing he maintained at least a "B" average toward his B.E. degree. After one year in the professional school the student is awarded a B.S. degree in engineering and returns to his specialty in industry. This is route C on the Figure 1.

If the student, after his industrial internship, desires to work in development, design, or technical service or as a research assistant, he must return to the professional school for a period of 2 years (24 months) for further specialized training in these fields. At the end of a 2-year period he is awarded an M.S. degree in engineering. This is route D in Figure 1.

Others may choose Route E toward the field of basic engineering research for a 3-year (36 months) study. They would then be awarded the Ph.D. Degree or Doctor of Engineering degree.

The three routes may be in the same professional school or they may be on separate campuses at other colleges. The three routes need not have similar courses and a graduate of route A cannot automatically enter route B with one-half of his course work completed. The courses and fields of study may be entirely different in the three routes.

**Industry's Role.** Industry must decide immediately which work is that of engineers and which is the work of assistants, aides or technicians. Further, industry must be discriminate in the use of the title "Engineer." The use of this title by operators, laymen, etc. should be banned. The engineers must be supplied with assistance to carry on the chores of drawing, graphing, analytical and other non-engineering jobs. In this way, industry will do a much better job of utilizing engineers and will also carry a much larger share of the cost of education.

Industry will need technicians desperately in 1984 just as it does today. It has been estimated that about four times as many young men are qualified to become technicians as are qualified to become engineers. The technician is obtained through high quality technical-institute training and not through poor engineering training. In the 1984 plan (Figure 1) the three year graduate can be the technician of the future.

**Within 25 Years.** Certainly by 1984 the present universities will be mostly senior and graduate institutions. The present day junior colleges will be enlarged to handle greater enrollment and also to increase course offerings to the junior and possibly senior levels. Under the 1984 Plan, these junior colleges could conceivably extend their offerings so that they could grant the 3-year degree. The universities may then be composed of the professional schools of engineering, medicine, law, business administration, arts, sciences, and others, exclusively on the once-called "graduate" level.

It is time for an education "engineer" to begin replacing the patched up curricula with brand new miracle materials to carry our education objectives to their future destinies.


## About the Author

**John J. McKetta** is chairman of the Chemical Engineering department at The University of Texas. A member of numerous professional societies in his field, and active on many national committees, he is a national director of AIChE, member of the board of regents of Tri-State College, member of the board of directors of five companies, and is an active consulting engineer. Dr. McKetta is chairman of the editorial committee of PETROLEUM REFINER, and was its editorial director from 1952-54. He has written more than 50 technical articles, many chapters in various technical books, and is co-author with Dr. K. A. Kobe of an outstanding series of books on "Advances in Petroleum Chemistry and Refining." He has a B.S. degree in chemical engineering from Tri-State College, and M.S. and Ph.D. degrees from the University of Michigan, and both schools have honored him with the title "Distinguished Alumnus."



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## Welded pressure vessels . . .

# The Inside Story on Code Inspection

**An inspector tells what the ASME code requires of vessel inspection and the steps necessary for code qualification**

**E. C. Korten**
The Hartford Steam Boiler Inspection and Insurance Co.
Hartford, Conn.

THE CODE is written by a committee of ASME formerly known as "The Boiler Code Committee" and now known as "The Boiler and Pressure Vessel Committee." Its functions are to prepare rules for safe construction of new pressure-carrying equipment, to interpret the rules they have written when questions arise and by means of periodic revisions, to keep the code abreast of progress as closely as it is possible to do so. Contrary to the opinions of many, the code is not intended to apply to repairs or alterations of installed equipment.

The rules in the code are made effective and compliance made mandatory by states or municipalities giving them the force of law by legislative action by which all or part of the code is adopted by the legal jurisdiction. In addition to adopting all or part of the code for new construction, each city or state writes its own requirements for installation and repair.

One of the fundamental requirements of the code is inspection during construction by someone who has no direct interest in the fabrication, sale, or use of the object. To this end **the code stipulates that *only* a State Inspector, a Municipal Inspector or an inspector regularly employed by an insurance company may be accepted as a qualified inspector.**

When Section VIII, Unfired Pressure Vessels, of the ASME Code was revised in 1950, Par. UG-91 made provision for "USER" inspection to parellel the API-ASME Code which has since been discontinued. Par. UG-91 permits inspection by "An Inspector continuously employed by a company for making inspections of unfired pressure vessels to be used by such company and not for resale." To clarify the original intent, a recent revision of Par. UG-91 added the words "The Inspector shall not be in employ of the manufacturer." This type of inspection is not recognized by all enforcement jurisdictions. If its use is contemplated, a check with the enforcement authorities having jurisdiction at the point of installation is advisable.

**The qualifications of an inspector are determined by an examination as prescribed under the rules of any state or municipality which has adopted the code.** Inspectors passing such examinations are given a commission authorizing them to act for the legal jurisdiction and each inspector is answerable to the issuing authority for his acts under that commission. He is subject to revocation of his commission by the issuing authority for cause regardless of who his employers may be and Insurance Inspectors' Commissions are automatically forfeited when the individual leaves the employ of the company he was with when he took his examination.

As an indication of compliance with the requirements of the code, the Code Committee developed a symbol stamp to be applied to the completed object. The original stamp has since grown into quite a family. In addition to code stamping, each legal jurisdiction required stamping to indicate compliance with its standards which varied in more or less important details with each jurisdiction. In the early days, this led to an intolerable situation. I have seen small portable boilers stamped with as many as a dozen state standards. To ease this situation and bring about interchangeability of equipment from state to state and a standard which would be acceptable to any state, the National Board of Boiler and Pressure Vessel Inspectors was organized in 1919, five years after the first code was printed. Membership is available to chief inspectors or other officials charged with the enforcement of boiler and pressure vessel regulations of any subdivision of the United States or Canada that has adopted the ASME Code. The purpose of the National Board is to "promote greater safety to life and property by securing concerted action and maintaining uniformity in the construction, installation, and inspection of steam boilers and other pressure vessels and their appurtenances and to secure interchangeability between political subdivisions of the United States." **Today, all states with boiler or pressure vessel laws, with the exception of Pennsylvania and Ohio will accept objects bearing National Board stamping,** and these two states will also accept them provided the inspector signing the data sheet holds a commission in the state in which the object is to be installed. The National Board has gradually taken over preparation of inspectors' examinations, thus bringing about better uniformity in that respect.

Mention was previously made of repairs and alterations. **The National Board has also issued, and revised**

**from time to time, a set of Rules for Repair by Fusion Welding which is recognized by most legal jurisdictions and it is this set of rules and not the several sections of the ASME Code which should be followed in making repairs or alterations to existing equipment.** Copies may be obtained for a nominal sum by writing to the National Board of Boiler and Pressure Vessel Inspectors, 1155 North High Street, Columbus, Ohio.

**The Code holds the manufacturer responsible for compliance** with its requirements and provides for the application of its official stamp to the completed object and the signing of a data report to indicate compliance. It should be noted here that **the stamp is applied by the manufacturer in the presence of the inspector and not by the inspector himself,** and also that the manufacturer is required to sign the data report certifying to code compliance. The inspector is also required to sign a certificate of compliance on the data sheet. This is in effect a countersignature certifying that the manufacturer's statements are correct.

The final user of the code is the purchaser. Fundamentally, it is he who is responsible for compliance with the law of the jurisdiction in which he is located. However, in actual practice, the purchaser usually specifies that the equipment he buys shall comply with the requirements of the state or city in which he intends to install it. This just passes the buck back to the manufacturer, so manufacturers should have at least some knowledge of legal requirements of the several states and cities as respects pressure-carrying equipment. The best guide to basic requirements is the National Bureau of Casualty Underwriters' Bulletin "Synopsis of Boiler Laws, Rules and Regulations." This can be obtained from the Bureau at 60 John Street, New York 7, N. Y., for a nominal sum. It is brought up to date annually. However, it should not be relied upon completely. Requirements should be checked with the departments mentioned in the Synopsis as having jurisdiction.

**Building Code Vessels.** Obviously, the first step is to purchase those sections of the code covering the field in which you intend to operate. **You should have Section II covering Materials and Section IX covering Welding Qualifications no matter what the field.** In addition, you should have one or more of the following Sections; Section VIII on Unfired Pressure Vessels, Section IV on Low Pressure Heating Boilers, Section I on Power Boilers or Section V on Miniature Boilers, depending on what you intend to build.

**It is also advisable to subscribe to interpretation service which automatically brings you copies of all interpretations issued by the Boiler & Pressure Vessel Committee.** Pink sheet addenda to each section are printed twice each year and these addenda incorporate as many of the Code Interpretation Cases as possible, thus maintaining Interpretation Cases at a minimum. **Every three years a new edition of the code is printed incorporating all addenda therein.**

**Inspection Agreement.** The second step is to secure a written agreement to furnish inspection service from an authorized inspection agency. These are: a state, a city, or an insurance company. Commercial inspecting agencies are not included.

The reason for securing a written agreement will become clearer when the next step is explained. For the moment, the important point is that all the insurance companies who do that kind of work are somewhat overburdened and shop inspection service is not always available at a moment's notice for the asking. Hence, be sure you have a written agreement before you take Step Number 3.

**Three types of agreements are often made. They are: Plan 1, Full-Time, which provides a full-time resident inspector; Plan 2, Part-Time, which provides service on Mondays, Wednesdays and Fridays of alternate weeks and Tuesdays and Thursdays of every other week; and Plan 3, providing intermittent service on request upon 48 hours' advance notice.**

**Step No. 3 is the application to ASME for the symbol stamps required.** When the request is received by the society, the Secretary will send an application blank requesting certain information. One of the questions requires that you name the inspecting agency with which you have arranged for shop inspection service. Note the past tense. It is significant.

**When ASME receives your reply, the Secretary** will write to the agency named and acquaint them with the fact that you have applied for certain symbol stamps and named them as your inspecting agency. The letter **requests confirmation of the agreement to furnish inspection service. Unless an affirmative reply is received, the requested stamps will not be issued.** Now you see why a *written* agreement was emphasized.

**Symbol Stamps.** Many applicants for code stamps are under the impression that if they contemplate doing any work in the shop or field on boilers or pressure vessels or both, they need the S stamp, the U stamp, or both. This is not uniformly true. As I previously mentioned, the original S stamp has grown to be quite a family. If you are going to build new boilers in the shop, you need an S stamp. **If you are going to build pressure vessels, you need the U stamp;** miniature pressure vessels, the UM stamp; heating boilers, the H stamp; miniature boilers; the M stamp. Possession of any of these stamps will cover any work which you start in your own shops and complete in the field yourself.

However, **if you are engaged only in field work** and do not have a shop for the fabrication of new equipment, in order to assemble a boiler on which you did none of the shop work, **all you need is the Assembler's A stamp and if you are going to do only piping work either in the shop or in the field, all you need is the ϙP stamp. If you are engaged only in repair or alterations to existing equipment, you need no code symbol stamps.**

Step Number 4 is to register as a manufacturer with the National Board and with those states requiring individual registration. At present these are, Pennsylvania, Ohio, Delaware and Massachusetts.

Step Number 5 is to draw up a welding procedure specification.

The theory back of the requirements of Section IX is that there are certain known variables that can affect the quality of a weld and that if those variables are covered in a written procedure specification, anyone who has demonstrated his ability to produce sound welds and who followed that written procedure, would

produce a weld of predictable quality.

**Welding Procedure. Section IX states that each manufacturer or contractor shall record in detail the procedure he follows in the construction of weldments built in accordance with the Code. He is free to use any method he chooses, but he must record that method with sufficient clarity so that it can be repeated.** Suggested forms showing the information required are given in the Appendix to Section IX. Following these forms is not mandatory, but reasonable uniformity in the format of procedures is a great help to all concerned in checking the procedure to see that everything is properly covered and in actually applying it to weldments after it has been qualified.

The question is often asked as to how detailed a welding procedure should be. If that question is considered in connection with a procedure for manual metal arc welding, the basic concept will be clarified sufficiently to enable you to apply it to any other method of welding.

First, **the procedure should be titled and should be given an identifying number and should be dated.**

If I were the inspector servicing your plant, the first thing I would want to know would be how you are going to stick these things together. Your procedure should tell me "by the manual metal arc process."

Next, I would want to know what you are going to stick together, so **your procedure should identify the material, preferably by an ASME designation** because you intend to build to the code. You can use ASTM identification or give the chemistry and physical properties, but this should be done only when you intend to work with special material permitted by a code case. Don't make it too broad by just referring to "materials listed under P-1." The note at the top of Table Q11.1 cautions against this. For example, you wouldn't expect a procedure covering SA-283, Grade A carbon steel plates, to be applicable in all its details to the perhaps farfetched, but nevertheless possible, joining of SA-129, Grade A iron plates to SA-212, Grade B carbon silicon steel plates. The point is that if you want to avoid misunderstanding and controversy, be reasonably specific.

Having learned what you are going to stick together, I would next want to know what you are going to use as an adhesive. So, **I would expect your procedure to tell me that you will use electrodes conforming to a certain AWS classification number.** This is the best designation as it permits you to use any manufacturer's product bearing that classification. **You can name them by trade names** or manufacturer's designation if you want to **but if you do that, don't add "or equal."** If you must name them, name all you think you might want to use because you will be confined to only those specifically named.

**The position of the work during application is important.** Obviously, the technique used in downhand or flat position welding will differ from that used in welding overhead. A single procedure can cover more than one position but if that is done, it is necessary to spell out the technique for each position. **By including several positions in one procedure, you save repetition of those items applicable to all positions.** On the other hand, you complicate the procedure specification if you attempt to include too much and you make it difficult to dig out those details applicable to the position in which you may be interested at the moment. **Generally speaking, it is best to confine a specification to one position,** but inclusion of more than one is not prohibited as long as the intent is clear for each position covered.

As indicated in the suggested form, **the preparation of the base material can best be shown by sketches.** The written paragraph should include a reference to sketches by designating number rather than by the words, "attached sketches" only. The details to be shown on the sketches are rather clearly described in the suggested form so it does not seem that this item needs further comment.

Indication of electrical characteristics is simple and straightforward. Just make a statement as to whether a.c. or d.c. current will be used and in the case of d.c., whether the base material will be on the positive or negative side of the line.

**Welding Technique. Joint welding procedure or welding technique, should be clearly shown on a separate sketch or may be shown on the same sketch with the joint preparation.** Here again, the intent is clearly indicated in the code. **These sketches should show the number of passes or layers and whether they are weaving or stringer beads. They should show electrode sizes for each pass and the mean voltage and current for each size of electrode.** All this information should be given for each thickness to be welded. If more than one position is covered by the specification, here is where any changes in any of the items mentioned should be clearly indicated for each position. In the case of vertical welds, progression upward or downward should be indicated. **The point that seems to create the most controversy is the intent of the words "mean voltage and current."** It is generally customary to indicate upper and lower limits of voltages and current. In a number of instances, manufacturers have taken the position that it is permissible to add a further variation to these limits. They argue that a statement to the effect that current may vary between 170 and 230 amps. is stating *about* what it should be or that it is a "mean" and that further variation is permissible. Until the 1952 edition, the code listed a number of limitations of variables which included a requirement that the procedure must be requalified if the specified mean arc voltage and amperage was changed more than 15 percent above or below the specified mean. That established the limits of variation permitted under the code. **"Mean" is intended to refer to a single specified average figure or the average of the specified upper and lower limits, neither of which should be more than 15 percent above or below the average.**

Next, a statement regarding cleaning is important. The cleaning of the base material is usually covered in the paragraph on Preparation of Base Material so this paragraph need only mention the extent and manner of cleaning each deposited weld bead or layer.

**A statement as to treatment of defects should be included.** It is not advisable to slavishly copy the statement appearing in the suggested form. For example, flame gouging is detrimental to some material. Also, removal of defects appearing on the surface of any bead of welding may not cover the subject sufficiently. Sometimes it is necessary to remove defects disclosed by radiographing or other nondestructive tests, in which

case the permissible method of defect removal should be clearly indicated.

**Peening** is a controversial subject. **It should not be mentioned at all in a welding procedure specification** except in those rare special cases in which the desired result cannot be achieved by any other means, and then only in such a manner as to clearly indicate all details of the peening operation.

Treatment of the underside of the welding groove is intended to indicate whether or not a backing strip will be used and if not, whether the underside will be back-chipped or not.

**Preheating Base Metal.** Preheating and temperature control should be mentioned only if they are to be used. This will, of course, depend on the air hardening characteristics of the base material and should be carefully indicated when it is to be used. In those specifications covering a range of base material such as would be the case in referring to a P number in Table Q-11, the statement is sometimes made that preheating during welding and temperature control after welding will be in accordance with the requirements of the code under which the welding is being done. This is acceptable, but it can cause disagreement. **It is best to be reasonably specific as respects base material and to clearly indicate the extent to which preheating and temperature control are necessary for these materials.**

**The same comments apply to heat treatment** which includes stress relief or as it is sometimes called "post heating."

Other variables will have to be covered when other processes are used. For example, **in submerged arc welding, flux and rate of travel must be specified. For shielded arc welding, the size of the tungsten electrode, the kind and rate of flow of shielding gas, and in the case of all automatic welding, the rate of travel should be indicated.**

The basic principle that should be kept in mind is that any variable which would affect the quality or characteristics of the finished weld should be spelled out sufficiently to make the intent clear and still allow sufficient leeway for practical application.

Step Number 6 is to submit your welding procedure to your authorized inspecting agency for review. Frequently his experience can be of material assistance to you in eliminating causes for future bickering over intent. This step is not mandatory as the code holds the manufacturer responsible for drawing up a proper welding procedure specification. **A review of the welding procedure before qualification tests are started is extremely helpful in getting started right and minimizing arguments** over intent later on.

**Qualification.** The seventh and final step has two parts, namely, qualification of the procedure and qualification of the individual welders.

**The code holds the manufacturer or contractor responsible for the welding done by his organization and for the tests required to qualify the procedures and welders who apply these procedures.**

**The authorized inspecting agency is not required to witness the preparation of the test pieces or the testing of the specimens,** although it may do so if it so desires. **The code requires the manufacturer or contractor to maintain a record of test results of welding procedures and individual welders. These records are required to be certified by the manufacturer and to be accessible to the authorized inspector.** Manufacturers generally keep the test specimens for examination by the inspector also.

In the early days of welding, Hartford was very active in the field of procedure and operator qualification. We not only witnessed the welding of the test specimens but also witnessed the tests themselves and signed the record of qualification tests. Today, with a more widespread use of welding and better understanding of code requirements, we do not make it a practice to do either. However, we assist newcomers into the field all we can—sometimes actually witnessing either the preparation of the specimens or both the preparation and testing. Also, in those cases where we feel there is reason to doubt, we ask that specimens be prepared and tested in the presence of our inspector. Normally, we only examine the manufacturer's written welding procedure and his records of qualification of procedure and welders, all of which he is required to have available. Usually, the actual tested specimens are also examined. However, this may not be possible when some time has elapsed since the tests were made.

**To qualify a procedure, the code requires that the welder prepare test specimens following the written welding procedure in all details.** These test specimens are subjected to two types of tests for groove welds and one for fillet welds. Qualification used in groove welds also qualifies for fillet welds but not vice versa.

Tension tests are used to measure the tensile strength of groove weld joints and guided bend tests are used to check the soundness and ductility.

**The geometry and number of tests specimens required and the criteria by which they are judged acceptable or unacceptable are clearly indicated in the text and figures in Section IX** and needs no comment so we shall proceed to the second half of the last step, namely, qualification of individual welders, designated in the code as "Performance Qualification." The performance qualification tests are intended to determine the ability of welders and welding operators to make sound welds.

A welder is one who is capable of performing a manual or semi-automatic welding operation.

A welding operator is one who operates a machine or automatic welding equipment.

**Each welder must pass the tests prescribed in Section IX. He is required to make groove welds in complete accordance with the procedure specification or standard groove welds as set forth in the code for Welder Qualifications, or he may make the required fillet weld cast specimens. Qualification in groove also qualifies for fillet, but qualification in fillet is for that type only.**

The welder who prepares the procedure qualification test specimens is also qualified individually.

The essential variables and test results must be recorded for each welder and these records must be kept available to the authorized inspector.

**A change in any one of the essential variables requires requalification. A welder must also be requalified when he has not used a specific process for three months or more or when**

**About the Author**

**E. C. Korten** is assistant chief engineer in the Boiler division, The Hartford Steam Boiler Inspection & Insurance Co., Hartford, Conn. He supervises the company's shop inspection service, and handles all problems in the design and construction of pressure-carrying equipment. He received a B.S. degree in mechanical engineering from Stevens Institute of Technology in 1922, and has been with Hartford Co. for 27 years in various engineering capacities. He previously was with Thomas E. Murray, Inc., and New York Edison Co. for nine years.

**there is reason to question his ability to meet the specification.**

Welding operators require somewhat different qualification, soundness being determined by radiographic examination and sectioning rather than by guided bends.

**Shop Inspection.** As previously stated, an inspector must be a state or municipal inspector or an inspector regularly employed by an insurance company, whose qualifications have been determined by examination.

Examinations in most states are now conducted by the National Board and commissions issued by the National Board are recognized in most states. Your inspector should have a National Board Commission or a commission from the jurisdiction in which the inspected object will be installed. If your products are widely distributed, it is well to be sure that the inspector has a National Board Commission and an Ohio and Pennsylvania Commission. These two states will accept equipment stamped Code and National Board but they also require that the inspector signing the data sheets hold a commission from the state in which the object will be installed.

The Code stipulates that the inspector shall make such inspections as he considers are necessary, in order to satisfy himself that all requirements of the Code have been met. It formerly required that each object be inspected at least in certain specified stages of its construction. With the development of assembly-line methods, it became impossible for the inspector to comply literally with such requirements so they were modified as I have indicated.

**In shops producing** what we usually refer to as **"tailor made" equipment,** the procedure will be about as follows:

**1. The inspector will check welding procedure specifications and examine the records of qualification tests of procedure and welders.**

**2. He will request shop drawings of the equipment to be fabricated together with the manufacturer's computations showing that all pressure-carrying parts were designed in accordance with Code requirements. He will check the drawings and computations and call the manufacturer's attention to any corrections he deems necessary in order to comply with Code requirements.** This step is taken because it is felt that it is better that such corrections be made while the project is in the drafting stage rather than to require alterations in partly or wholly completed objects.

3. Having satisfied himself as respects welding qualifications and compliance of design, **the inspector will next examine the material for visible defects and check materials with mill test reports which the manufacturer should have available.**

**4. The inspector will next** want to **examine the object during fit-up at which time he will check the plate preparation for welding and fit-up to see that they are within tolerances.**

**5. Another examination will be made during welding to see that welders are following all details of the welding procedure.**

6. (a) If the vessel is to be x-rayed, **the inspector will examine all radiographs.** In this connection, do not ask him to examine the films until you are satisfied that they show acceptable welds. **It is the manufacturer's responsibility to find defects and correct them and not to depend on the inspector to do so.**

**6. (b) If stress relief is required, the inspector will examine the temperature charts to see that code requirements are fulfilled.**

**7. The inspector will witness the hydrostatic test and inspect the vessel internally and externally after the test.**

**8. The manufacturer will stamp the vessel in the presence of the inspector.** Note that the inspector does not stamp the vessel. He merely witnesses the stamping by the manufacturer.

**9. The manufacturer is required to sign the data sheet certifying that in building the vessel he complied with the code in all respects, and the inspector signs a statement to the effect that he made inspections as required by the Code** and has satisfied himself that the statements made by the manufacturer are correct.

In mass production shops the inspection procedure follows the same steps, but here each step cannot be taken on each vessel. The inspector will maintain overall observation of each operation in the shop and satisfy himself that each step in the fabricating process is kept within the required limits.

**Field Inspection.** Whether you are doing field work on boilers, pressure vessels or piping or are repairing or altering existing installations, **the one universally important requirement is that you have your written welding procedure specification on the job and available to the inspector and that you also have available properly completed records of qualification of both the procedure and the individual welders.** This is most essential as the inspector cannot even start his work until he has examined these documents.

**In so far as piping is concerned, the code covers only that portion between the boiler outlets and the stop valves. Piping beyond the stop valves or piping connected to unfired pressure vessels is not covered.**

Unfortunately, this piping has become somewhat of an orhpan. The code includes the piping up to the stop valves and most laws require compliance. Boiler manufacturers usually sell their boilers up to the steam outlet and therefore, unless the purchaser or his consultant is fully aware of this situation, the piping contractor, who does not have to meet the code for the majority of his installations, carries on up to the boiler and then when the inspector refuses to sign for work he was not given an opportunity to inspect, a lot of people get upset and we have quite a time trying to straighten out the mess. So, **a word of warning to piping contractors. Please don't weld piping within the boiler stop valves unless you, or someone else, has arranged for inspection by an authorized inspecting agency.** ##

# Find Blend Viscosity by Nomograph

## This nomograph eliminates the problem of cube roots in finding viscosity of oil blends

**D. S. Davis,** University of Alabama, University, Ala.

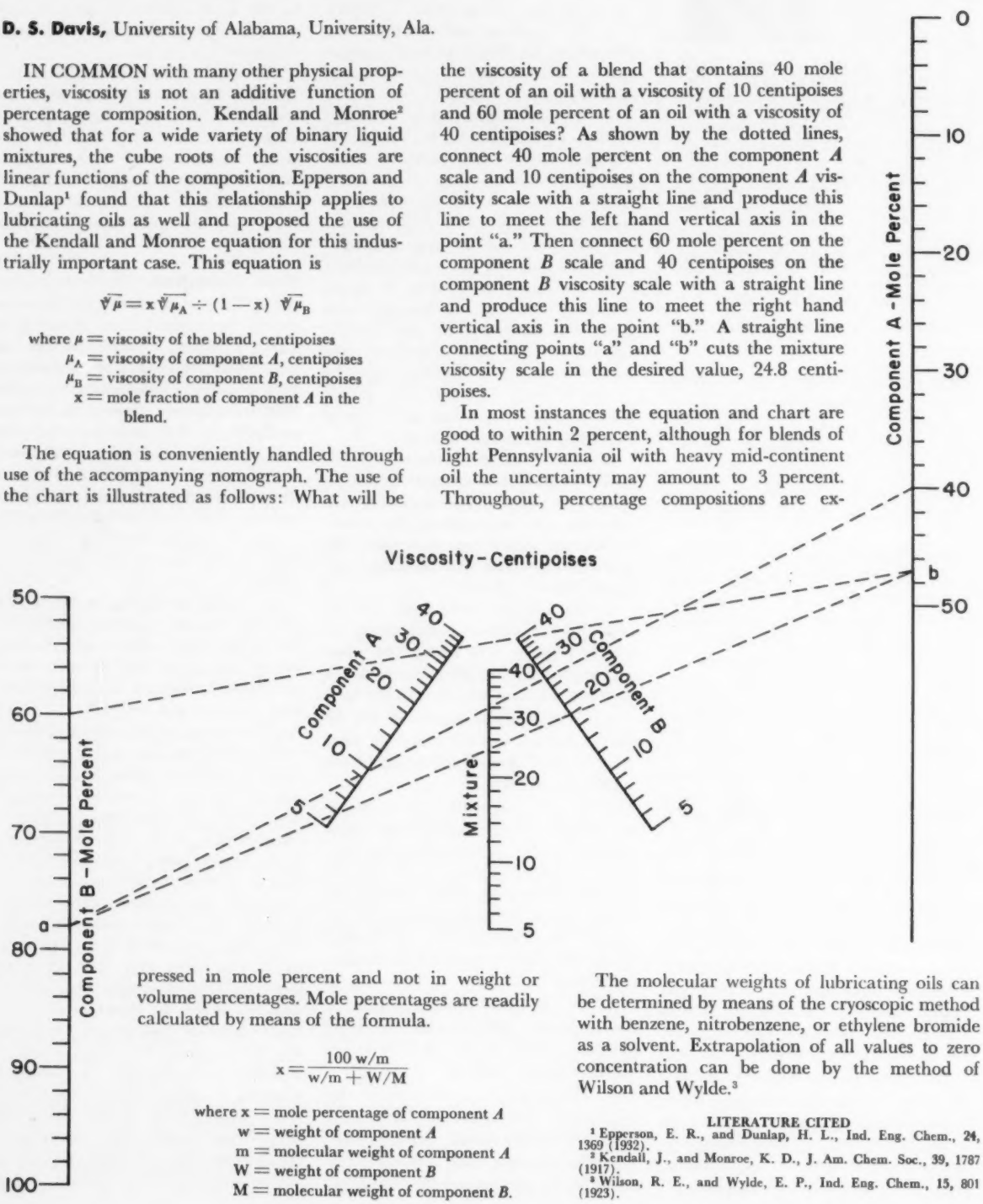
IN COMMON with many other physical properties, viscosity is not an additive function of percentage composition. Kendall and Monroe[2] showed that for a wide variety of binary liquid mixtures, the cube roots of the viscosities are linear functions of the composition. Epperson and Dunlap[1] found that this relationship applies to lubricating oils as well and proposed the use of the Kendall and Monroe equation for this industrially important case. This equation is

$$\sqrt[3]{\mu} = x\sqrt[3]{\mu_A} \div (1 - x)\ \sqrt[3]{\mu_B}$$

where $\mu$ = viscosity of the blend, centipoises
$\mu_A$ = viscosity of component *A*, centipoises
$\mu_B$ = viscosity of component *B*, centipoises
x = mole fraction of component *A* in the blend.

The equation is conveniently handled through use of the accompanying nomograph. The use of the chart is illustrated as follows: What will be the viscosity of a blend that contains 40 mole percent of an oil with a viscosity of 10 centipoises and 60 mole percent of an oil with a viscosity of 40 centipoises? As shown by the dotted lines, connect 40 mole percent on the component *A* scale and 10 centipoises on the component *A* viscosity scale with a straight line and produce this line to meet the left hand vertical axis in the point "a." Then connect 60 mole percent on the component *B* scale and 40 centipoises on the component *B* viscosity scale with a straight line and produce this line to meet the right hand vertical axis in the point "b." A straight line connecting points "a" and "b" cuts the mixture viscosity scale in the desired value, 24.8 centipoises.

In most instances the equation and chart are good to within 2 percent, although for blends of light Pennsylvania oil with heavy mid-continent oil the uncertainty may amount to 3 percent. Throughout, percentage compositions are expressed in mole percent and not in weight or volume percentages. Mole percentages are readily calculated by means of the formula.




$$x = \frac{100\ w/m}{w/m + W/M}$$

where x = mole percentage of component *A*
w = weight of component *A*
m = molecular weight of component *A*
W = weight of component *B*
M = molecular weight of component *B*.

The molecular weights of lubricating oils can be determined by means of the cryoscopic method with benzene, nitrobenzene, or ethylene bromide as a solvent. Extrapolation of all values to zero concentration can be done by the method of Wilson and Wylde.[3]

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# Use Enthalpy for Two-Phase ΔP

**Save time when calculating fired heater pressure drop for vaporizing fluids by using thermodynamic relationships**

**Alfred Doll-Steinberg**
Foster Wheeler, Ltd.
London

THE CALCULATION of the pressure drop for a vaporizing fluid in a fired heater depends on the solution of Equation (1) or of one of its variations, e.g., Equation (2). The difficulty of the calculation arises because the relations between the variables of these equations can seldom be expressed analytically and thus the chosen equation must be solved step by step, each step involving a trial-and-error calculation. This makes the calculation of the two-phase pressure drop a laborious and time consuming procedure.

Methods have been developed, e.g., by Maker,[1] and Buthod,[2] which simplify the procedure and give more accurate results than the original tube by tube calculation method.

Both methods involve calculating and plotting graphically the properties of the charge stock. Thus Maker uses a plot of pressure versus enthalpy with specific volume as the parameter and Buthod uses a Cox chart plot of the lines of constant percentage vaporization (the Phase Diagram) on which are superimposed lines of constant enthalpy. The relations which hold for the diagram of the latter form of plot will be examined further.

It is the purpose here to show how from the thermodynamic relations between the properties of the fluid it is possible to derive rules which simplify the task of constructing such a diagram. It will also be shown how it is possible to calculate from the properties of the fluid at the outlet from the heater, the conditions necessary to avoid peaking (i.e., a maximum of temperature occurring before the outlet of the heater).

The pressure drop for any flowing fluid is given by the Fanning equation.

$$dp = -\frac{w^2 V f\, dL}{2DA^2} - \frac{w^2}{2A^2} dV \qquad (1)$$

Making the usual assumption that in the radiant section (where all or the bulk of the vaporization nearly always takes place) a linear relation holds between the enthalpy of the fluid and the length of heater coil traversed, gives Equation (2)

$$dp = -\frac{w^2 V}{2DA^2} f\, C\, dH - \frac{w^2}{2A^2} dV \qquad (2)$$

The factor of proportionality, $C$, between increments of length of heater coil and increments of enthalpy is given by Equation (3).

$$C = \frac{L}{\frac{Q\pi DL_e}{w}} = \frac{Fw}{Q\pi D} \qquad (3)$$

To obtain $L$, the equivalent length of the return fittings in each pass is added to the actual length of heater coil.

$$L = L_e + nL_R$$

$$\text{and } F = \frac{L}{L_e}$$

As will be explained later, this method of allowing for the return bend pressure drop should strictly only be used where the pressure drop per return bend is small compared with the pressure of the fluid, and the results obtained from this approximation will not apply rigorously in other cases.

Besides being a function of the terms such as mass

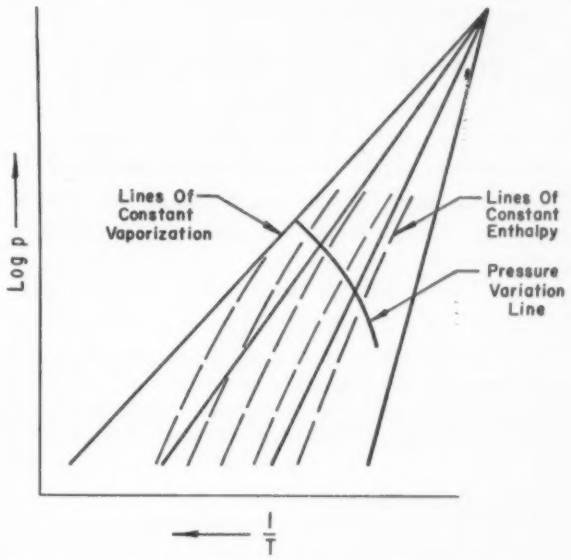
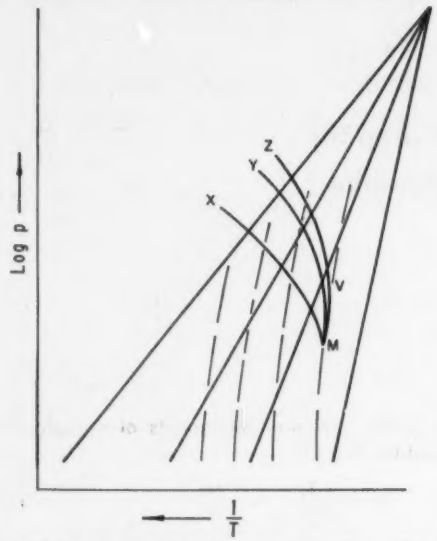
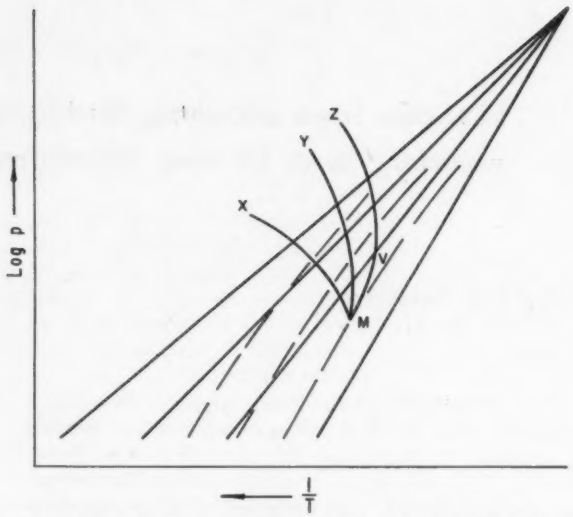



**FIGURE 1—Cox chart plot of fluid properties showing a typical pressure variation line.**




**FIGURES 2a and 2b—Forms of pressure variation possible for two different charge stocks. XM—no peak; YM—limiting condition for no peak; ZM—peak at V. Notice that in both diagrams the last section of ZVM has the maximum possible slope, i.e., that of the line of constant enthalpy through M. This emphasizes that peaking is most likely to occur with a charge stock having lines of constant enthalpy with a small slope.**

flow per pass, tube diameter, radiant rate, which are fixed by the design of the heater, the pressure at any point in the heater coil is a function of the specific volume and enthalpy of the fluid at that point, which are in turn functions of the fluid temperature and pressure. The line showing the pressure variation through the heater (the p.v. line) can therefore be plotted on the Cox chart.

The pressure drop will be determined by the properties of the fluid, which, on the Cox chart plot are expressed as the slopes and "spread" of the constant enthalpy and constant percentage vaporization lines. The relations existing between the slopes and between the "spreads" can be derived as follows.

The slope at any point of a line of constant enthalpy on a Cox chart plot is expressed mathematically as

$$-\left(\frac{\partial \log p}{\partial\left(\frac{1}{T}\right)}\right)_H$$

The minus sign expresses the fact that on the Cox chart, $\frac{1}{T}$ increases from right to left. Similarly, the slope at any point, of a line of constant percentage vaporization is expressed as

$$-\left(\frac{\partial \log p}{\partial\left(\frac{1}{T}\right)}\right)_y$$

Now small increments of enthalpy may be expressed as follows, (see, for example, Edmister[3])

$$dH=\left(\frac{\partial H}{\partial \log p}\right)_T d\log p+\left(\frac{\partial H}{\partial\left(\frac{1}{T}\right)}\right)_p d\left(\frac{1}{T}\right) \quad (4)$$

and for constant H, $dH=0$

$$\text{i.e. } \left(\frac{\partial \log p}{\partial\left(\frac{1}{T}\right)}\right)_H=-\frac{\left(\frac{\partial H}{\partial\left(\frac{1}{T}\right)}\right)_p}{\left(\frac{\partial H}{\partial \log p}\right)_T} \quad (5)$$

The enthalpy of a two phase mixture may be expressed as the sum of heat contents of the phases.

$$H=h_v y+h_l(1-y) \quad (6)$$

Differentiating Equation (6 with respect to $\frac{1}{T}$ at constant $P$, gives

$$\left(\frac{\partial H}{\partial\left(\frac{1}{T}\right)}\right)_p=-h_v\left(\frac{\partial y}{\partial T}\right)_p T^2+h_l\left(\frac{\partial y}{\partial T}\right)_p T^2$$
$$-y\left(\frac{\partial h_v}{\partial T}\right)_p T^2-(1-y)T^2\left(\frac{\partial h_l}{\partial T}\right)_p$$
$$=-\lambda T^2\left(\frac{\partial y}{\partial T}\right)_p-yT^2\left(\frac{\partial h_v}{\partial T}\right)_p-(1-y)T^2\left(\frac{\partial h_l}{\partial T}\right)_p$$
$$\text{i.e.}\left(\frac{\partial H}{\partial\left(\frac{1}{T}\right)}\right)_p=-T^2\left(\lambda\left(\frac{\partial y}{\partial T}\right)_p+C_v y+C_l(1-y)\right) \quad (7)$$

Differentiating Equation (6) with respect to log $p$, at constant $T$, gives

$$\left(\frac{\partial H}{\partial \log p}\right)_T=h_v\left(\frac{\partial y}{\partial \log p}\right)_T+y\left(\frac{\partial h_v}{\partial \log p}\right)_T+$$
$$(1-y)\left(\frac{\partial h_l}{\partial \log p}\right)_T-h_l\left(\frac{\partial y}{\partial \log p}\right)_T \quad (8)$$

For the liquid phase, enthalpy is almost independent of pressure, and making the assumption that the vapor phase is approximately ideal, we can say that enthalpy is independent of pressure for this phase also.

Hence, Equation (8) simplifies to

$$\left(\frac{\partial H}{\partial \log p}\right)_T=h_v\left(\frac{\partial y}{\partial p}\right)_T p-h_l\left(\frac{\partial y}{\partial p}\right)_T p$$
$$\text{i.e.}\left(\frac{\partial H}{\partial \log p}\right)_T=\lambda p\left(\frac{\partial y}{\partial p}\right)_T \quad (9)$$

Substituting from Equations (7) and (9) into Equation (5) gives the result

$$\left(\frac{\partial \log p}{\partial\left(\frac{1}{T}\right)}\right)_H = \frac{T^2\left(\lambda\left(\frac{\partial y}{\partial T}\right)_p + C_v y + C_l(1-y)\right)}{\lambda p\left(\frac{\partial y}{\partial p}\right)_T} \quad (10)$$

The slope of the lines of constant percentage vaporization is given by the well-known Clausius Clapeyron equation in the form

$$\left(\frac{\partial \log p}{\partial\left(\frac{1}{T}\right)}\right)_y = -\frac{\lambda}{R} \quad (11)$$

Now since $y$ is a unique function of $p$ and $T$ (or $\left(\frac{1}{T}\right)$) the usual relation holds for $dy$:

$$dy = \left(\frac{\partial y}{\partial p}\right)_T dp + \left(\frac{\partial y}{\partial\left(\frac{1}{T}\right)}\right)_p d\left(\frac{1}{T}\right) \quad (12)$$

hence for constant $y$

$$\left(\frac{\partial p}{\partial\left(\frac{1}{T}\right)}\right)_y = -\frac{\left(\frac{\partial y}{\partial\left(\frac{1}{T}\right)}\right)_p}{\left(\frac{\partial y}{\partial p}\right)_T}$$

or

$$\left(\frac{\partial \log p}{\partial\left(\frac{1}{T}\right)}\right)_y = -\frac{\left(\frac{\partial y}{\partial\left(\frac{1}{T}\right)}\right)_p}{\left(\frac{\partial y}{\partial p}\right)_T p} \quad (13)$$

Substituting from Equation (11) into Equation (13), and rearranging the result gives

$$\left(\frac{\partial y}{\partial p}\right)_T = \frac{R}{\lambda p}\left(\frac{\partial y}{\partial\left(\frac{1}{T}\right)}\right)_p = -\frac{RT^2}{\lambda p}\left(\frac{\partial y}{\partial T}\right)_p \quad (14)$$

and thus, Equation (9) may be written as

$$\left(\frac{\partial H}{\partial \log p}\right)_T = -RT^2\left(\frac{\partial y}{\partial T}\right)_p \quad (15)$$

Substituting Equations (7) and (15) into Equation (5) gives

$$\left(\frac{\partial \log p}{\partial\left(\frac{1}{T}\right)}\right)_H = -\frac{\left(\lambda\left(\frac{\partial y}{\partial T}\right)_p + C_v y + C_l(1-y)\right)}{R\left(\frac{\partial y}{\partial T}\right)_p} \quad (16)$$

Rearranging this, and substituting for $\frac{\lambda}{R}$ from Equation (11) gives

$$-\left(\frac{\partial \log p}{\partial\left(\frac{1}{T}\right)}\right)_H - \left(-\left(\frac{\partial \log p}{\partial\left(\frac{1}{T}\right)}\right)_T\right) = \frac{C_l + (C_v - C_l)y}{R\left(\frac{\partial y}{\partial T}\right)_p} \quad (17)$$

From this equation it is seen that, since for petroleum fractions at least, $C_l$ will always exceed the largest value that $(C_v - C_l)y$ can assume, namely $(C_v - C_l)$ (which may be positive or negative) and since $\left(\frac{\partial y}{\partial T}\right)_p$ is always positive, it follows that the constant enthalpy line at any point on the Cox diagram will have a slope greater than the line of constant vaporization at the same point. The difference in slopes will depend most strongly on the magnitude of $\left(\frac{\partial y}{\partial T}\right)_p$ since this is the quantity subject to the greatest variation.

## The Physical Significance of $\left(\frac{\partial y}{\partial T}\right)_p$

$\left(\frac{\partial y}{\partial T}\right)_p$ is an inverse measure of the "spread" of the grid of lines of constant vaporization. Thus, the narrower the boiling range of the fluid, the larger this quantity will be, until in the limit, for a pure one-component substance its magnitude is infinite, since at constant pressure the vaporization all takes place at constant temperature.

For a pure one-component substance, therefore the "grid" becomes a single line and it is not possible to represent the lines of constant enthalpy in the two phase region, since they are superimposed on each other and on the vaporization line.

It follows therefore from this and from Equation (17) that for narrow boiling range fluids the lines of constant enthalpy will approach parallelism with the constant vaporization lines. Note also that since for all fluids $\left(\frac{\partial y}{\partial T}\right)_p$ increases with pressure, the lines of constant enthalpy will be curved, having smaller slopes at higher pressures.

This knowledge can save time and prevent errors caused by drawing the grid of enthalpy lines from points spaced too far apart.

The interval between successive lines of constant enthalpy is derived as follows:

$H = h_l + (h_v - h_l)y$ from Equation (6)

i.e. $H = C_l T + \lambda y$ (18)

and approximately

$$\Delta H = C_l \Delta T + \lambda \Delta y$$

$$\text{or } \Delta H = \left(C_l + \lambda \frac{\Delta y}{\Delta T}\right) \Delta T \quad (19)$$

Thus for given increments, $\Delta T$, $\Delta H$ will be large when $\Delta y/\Delta T$ is large; for narrow boiling range stocks successive lines for given increments of enthalpy will be close together, and of course for a pure component which has an infinitesimally small boiling range at a fixed pressure, the lines of constant enthalpy on a Cox chart are superimposed on each other and on the vaporization line.

Equation (19) may also be written as

$$\Delta H = -\left(C_l + \lambda \frac{\Delta y}{\Delta T}\right) \Delta \left(\frac{1}{T}\right) T^2 \quad (20)$$

which shows that on the Cox chart the lines of constant enthalpy will be spaced closer together at the high temperature end since smaller increments of $\frac{1}{T}$ will correspond to the same increments of H.

The results expressed by Equations (17) and (20) and explained above will help the designer to draw the grid of constant enthalpy lines from the minimum number of calculated points.

### Pressure Variation

Having established the fundamental relations which exist for the phase diagram, it is possible to examine the pressure variation line. (The line drawn on the phase diagram showing the variation of pressure through the

heater coil.) The path of any such line is limited by two considerations.

1. From the inlet to the outlet of the heater, the enthalpy of the fluid must continuously increase.

2. From the inlet to the outlet of the heater the pressure of the fluid must continuously decrease.

Thus on the phase diagram, the pressure variation (p.v.) line must always slope downwards and can never cross twice any given line of enthalpy.

In the usual design of fired heaters where there is a common tube size in the radiant section and the vaporization in the convection section is zero or small, the greatest rate of pressure drop with distance, and thus with enthalpy, occurs at heater outlet where the vaporization is highest and the pressure is lowest. This means that $-\left(\frac{d \log p}{dH}\right)$ measured along the variation line, has its greatest value at the heater outlet. It can be shown as follows, that this implies that the angle which the variation line makes with the $\left(\frac{1}{T}\right)$ axis has its smallest value at the heater outlet.

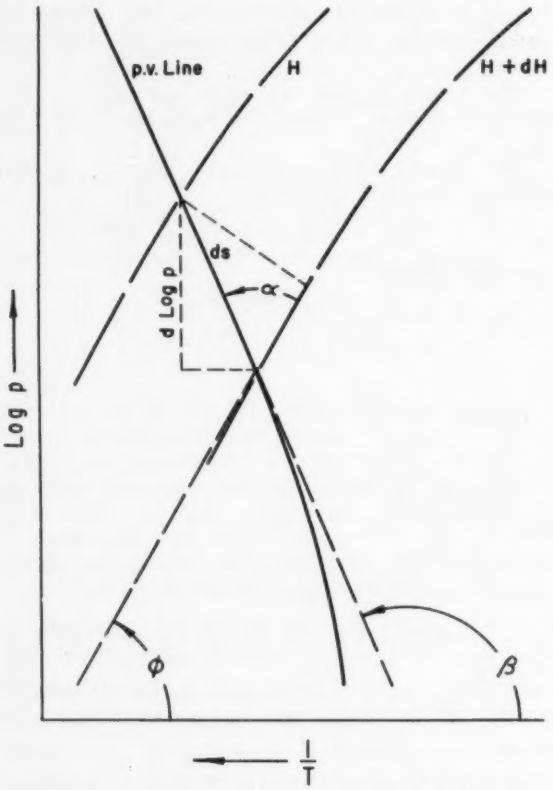



**FIGURE 3—Shows the geometric relationships of an element of the pressure variation line of length ds.**

Figure 3 shows an element of the variation line, and the angular relationships of this element. Using the notation shown in the figure

$$\left.\begin{aligned} -d \log p &= ds \sin \beta \\ dH &= K\, ds \sin \alpha \end{aligned}\right\} \qquad (21)$$

where $K$ is the factor relating distance, measured perpendicular to the constant enthalpy lines, to enthalpy change in the region of the phase diagram under consideration.

Then

$$-\left(\frac{d \log p}{dH}\right) = \left(\frac{\sin \beta}{K \sin \alpha}\right) \qquad (22)$$

From the geometry of the diagram

$$\beta = \alpha + \phi \qquad (23)$$

Thus

$$K\left(-\frac{d \log p}{dH}\right) = \left(\frac{\sin \beta}{\sin (\beta - \phi)}\right) \qquad (24)$$

The expression may be differentiated with respect to $\beta$, as follows:

$$\frac{d\left(K\left(-\frac{d \log p}{dH}\right)\right)}{d\beta} = \frac{\sin(\beta - \phi)\cos\beta - \sin\beta\cos(\beta - \phi)\left[1 - \frac{d\phi}{d\beta}\right]}{\sin^2(\beta - \phi)} \qquad (25)$$

Since $\phi$ varies much more slowly than $\beta$ along the pressure variation line, $\frac{d\phi}{d\beta}$ is negligible.

Thus,

$$\frac{\left(K\left(-\frac{d \log p}{dH}\right)\right)}{d\beta} = \frac{\sin(-\phi)}{\sin^2(\beta - \phi)} \qquad (26)$$

i.e. $\frac{d\left(K\left(-\frac{d \log p}{dH}\right)\right)}{d\beta}$ is always negative. This means that as $\beta$ increases so the product of $K$ and the rate of pressure drop decreases.

As shown in Equation (20) the lines of constant enthalpy are relatively more closely spaced towards the right of the phase diagram and higher in the phase diagram, i.e., at higher temperatures and at high pressures. In the usual case therefore the value of $K$ changes relatively little on the path of a pressure variation line, but $\left(-\frac{d \log p}{dH}\right)$ increases rapidly. Thus the product of $K$ and $\left(-\frac{d \log p}{dH}\right)$ will increase from the inlet to the outlet of the heater and since $\frac{d\left(K\left(-\frac{d \log p}{dH}\right)\right)}{d\beta}$ is negative this means that $\beta$ will decrease to its minimum value at the heater outlet.

Note that this result will apply only if the vapor is not superheated at outlet. At the 100 percent vapor line the constant enthalpy lines will exhibit a discontinuity and for a vapor the change of enthalpy with pressure is generally so small that the temperature will increase almost linearly to the outlet from the 100 percent vaporization point. In this case $\beta$ will decrease to its smallest value at the 100 percent point and will then increase discontinuously. Thus when the outlet condition is superheated vapor, the location of the point on the phase diagram where the vapor is just saturated (the 100 percent vaporization point) must be found by a trial and error pressure drop calculation and the formulas derived below can be applied to the conditions at this point.

This result, that the angle between the p.v. line and the $\frac{1}{T}$ axis has its minimum value at the heater outlet (provided that the fluid at outlet is not superheated vapor)

may be used to derive a formula which gives the limiting condition for no peaking.

Peaking will be indicated by a minimum of the p.v. line against the $\frac{1}{T}$ axis. Since enthalpy must increase along the p.v. line, $\beta$ cannot be less than $\phi$ at any point, and thus feed stocks which have vertical or nearly vertical lines of constant enthalpy will show little tendency to give a peak in any fired heater design. Conversely stocks which exhibit lines of constant enthalpy with small slopes (i.e., from Equation (17), having narrow boiling ranges) will require careful tube size selection if peaking is to be avoided or must be limited.

The limiting condition for no peaking is therefore that the p.v. line is vertical at the point representing the heater outlet. The formula for this limiting condition is derived as follows:

Equation (2) is rewritten by expressing pressure drop in terms of log p and dividing through by $d\left(\frac{1}{T}\right)$, giving Equation (27)

$$\frac{d \log p}{d\left(\frac{1}{T}\right)} = -\frac{w^2 Vfc}{2 DA^2 p}\frac{dH}{d\left(\frac{1}{T}\right)} - \frac{w^2}{2 A^2 p}\frac{dV}{d\left(\frac{1}{T}\right)} \qquad (27)$$

Defining $K_1$ and $K_2$ as follows:

$$K_1 = \frac{w^2 Vfc}{2 DA^2}\,;\; K_2 = \frac{w^2}{2 A^2}$$

Equation (27) may be simplified to

$$\frac{d \log p}{d\left(\frac{1}{T}\right)} = -\frac{K_1}{p}\frac{dH}{d\left(\frac{1}{T}\right)} - \frac{K_2}{p}\frac{dV}{d\left(\frac{1}{T}\right)} \qquad (28)$$

Now by the usual method for thermodynamic functions, the total differentials $\frac{dH}{d\left(\frac{1}{T}\right)}$ and $\frac{dV}{d\left(\frac{1}{T}\right)}$ are expressed in terms of their partial components.

$$\frac{dV}{d\left(\frac{1}{T}\right)} = \left(\frac{\partial V}{\partial p}\right)_T \frac{dp}{d\left(\frac{1}{T}\right)} + \left(\frac{\partial V}{\partial\left(\frac{1}{T}\right)}\right)_p$$

$$\frac{dH}{d\left(\frac{1}{T}\right)} = \left(\frac{\partial H}{\partial p}\right)_T \frac{dp}{d\left(\frac{1}{T}\right)} + \left(\frac{\partial H}{\partial\left(\frac{1}{T}\right)}\right)_p$$

Substituting these results in Equation (28) gives:

$$\frac{d \log p}{d\left(\frac{1}{T}\right)} = -K_1\left(\frac{\partial V}{\partial p}\right)_T \frac{d \log p}{d\left(\frac{1}{T}\right)} - \frac{K_1}{p}\left(\frac{\partial V}{\partial\left(\frac{1}{T}\right)}\right)_p - K_2\left(\frac{\partial H}{\partial p}\right)_T \frac{d \log p}{d\left(\frac{1}{T}\right)} - \frac{K_2}{p}\left(\frac{\partial H}{\partial\left(\frac{1}{T}\right)}\right)_p$$

$$\text{i.e. } \frac{d \log p}{d\left(\frac{1}{T}\right)} = \frac{-\left[\frac{K_1}{p}\left(\frac{\partial V}{\partial\left(\frac{1}{T}\right)}\right)_p + \frac{K_2}{p}\left(\frac{\partial H}{\partial\left(\frac{1}{T}\right)}\right)_p\right]}{1 + K_1\left(\frac{\partial V}{\partial p}\right)_T + K_2\left(\frac{\partial H}{\partial p}\right)_T} \qquad (29)$$

For the limiting condition for no peaking, the p.v. line at the heater outlet is vertical, i.e., $\frac{d \log p}{d\left(\frac{1}{T}\right)}$ is infinite, and from Equation (29) the expression

$$1 + K_1\left(\frac{\partial V}{\partial p}\right)_T + K_2\left(\frac{\partial H}{\partial p}\right)_T \text{ must be zero.}$$

Thus, substituting for $K_1$ and $K_2$ in terms of conventional units, the condition of no peaking is expressed by Equation (30)

$$0.811\frac{w^2}{D^4}\left(\frac{\partial V}{\partial p}\right)_T^\circ + \frac{0.258\, w^2}{D^4 Q} FV_o f\left(\frac{\partial H}{\partial p}\right)_T^\circ = -1 \qquad (30)$$

Where $w$ is the flow rate per pass in lbs./hr.

$D$ is the tube internal diameter in inches.
$V_o$ is the specific volume at outlet in cu. ft./lb.
$Q$ is the radiant transfer rate in Btu/hr. ft.$^2$, figured on the i.d.
$p$ is the pressure in p.s.i.
$H$ is the fluid enthalpy in Btu/lb.

and all the properties of the fluid are determined under the conditions existing at the heater outlet.

### Effect of Steam Injection

By modifying Equation (29) it is possible to calculate the quantity of steam required to avoid a peak under conditions where $D$ and $w$ are fixed, e.g., where the throughput of an existing heater is to be increased.

If $\pi$ is the partial pressure of oil vapor in the presence of steam, then

$$\pi = \frac{p\,\frac{y}{M}}{S + \frac{y}{M}} \qquad (31)$$

where $M$ is the molecular weight of the oil vapor. $S$ is the number of moles of steam per pound of oil.

Writing Equation (31) in the log form and differentiating with respect to 1/T gives

$$\frac{d \log \pi}{d\left(\frac{1}{T}\right)} = \frac{d \log p}{d\left(\frac{1}{T}\right)} - \frac{d \log\left(1 + \frac{Ms}{y}\right)}{d\left(\frac{1}{T}\right)} \qquad (32)$$

Expanding $\frac{d \log\left(1 + \frac{Ms}{y}\right)}{d\left(\frac{1}{T}\right)}$ expressed as a function of $\frac{1}{T}$ and $\log \pi$, in terms of its partial components gives

$$\frac{d \log \pi}{d\left(\frac{1}{T}\right)} = \frac{d \log p}{d\left(\frac{1}{T}\right)} - \left(\frac{\partial \log\left(1 + \frac{Ms}{y}\right)}{\partial\left(\frac{1}{T}\right)}\right)_\pi - \left(\frac{\partial \log\left(1 + \frac{Ms}{y}\right)}{\partial \log \pi}\right)_T \cdot \frac{d \log \pi}{d\left(\frac{1}{T}\right)}$$

$$\text{i.e. } \frac{d \log p}{d\left(\frac{1}{T}\right)} = \frac{d \log \pi}{d\left(\frac{1}{T}\right)}\left[1 + \left(\frac{\partial \log\left(1 + \frac{Ms}{y}\right)}{\partial \log \pi}\right)_T\right] + \left(\frac{\partial \log\left(1 + \frac{Ms}{y}\right)}{\partial\left(\frac{1}{T}\right)}\right)_\pi \qquad (33)$$

Thus, since $\left(\frac{\partial \log\left(1 + \frac{Ms}{y}\right)}{\partial \log \pi}\right)_T$ and $\left(\frac{\partial \log\left(1 + \frac{Ms}{y}\right)}{\partial\left(\frac{1}{T}\right)}\right)_\pi$ are functions of the fluid properties only, it follows that when $\frac{d \log \pi}{d\left(\frac{1}{T}\right)}$ is infinite so also is $\frac{d \log p}{d\left(\frac{1}{T}\right)}$. It is

not possible to show for the general case that $\frac{d \log \pi}{d\left(\frac{1}{T}\right)}$ has its maximum value at the heater outlet, as is the case in the absence of steam, but this is an assumption which is borne out in practice. Thus, taking the limiting conditions for no peaking to be as before, that the slope of the (oil vapor) pressure, $\pi$, versus $\frac{1}{T}$ line must be infinite at outlet from the heater we have from Equation (33) that $\frac{d \log p}{d\left(\frac{1}{T}\right)}$ is also infinite for the limiting condition.

Equation (30) still applies therefore in the presence of steam as the limiting condition for no peaking. It is rewritten, as follows, to give the unknown quantity, $S$, explicitly.

$$0.811 \frac{w^2}{D^5}\left(\frac{\partial V}{\partial \pi}\right)^\circ_T \left(\frac{\partial \pi}{\partial p}\right)^\circ_T + \frac{0.258\, w^2 V_o F f}{D^5 Q}\left(\frac{\partial H}{\partial \pi}\right)^\circ_T \left(\frac{\partial \pi}{\partial p}\right)^\circ_T = -1$$

$$\text{or } 0.811 \frac{w^2}{D^5}\left(\frac{\partial V}{\partial \pi}\right)^\circ_T + \frac{0.258\, w^2}{D^5 Q} V_o F f \left(\frac{\partial H}{\partial \pi}\right)^\circ_T = -\left(\frac{\partial p}{\partial \pi}\right)^\circ_T \quad (34)$$

where, from Equation (31)

$$\left(\frac{\partial p}{\partial \pi}\right)^\circ_T = \left(1 + \frac{Ms}{y_o}\right) - \frac{Ms\, \pi_o}{y_o^2}\left(\frac{\partial y}{\partial \pi}\right)^\circ_T$$

where all the fluid properties refer to conditions at the heater outlet.

Although a design for no peaking may not always be economic, and this is especially the case for narrow boiling range stocks, knowledge of the conditions for no peaking should assist the selection of conditions to give no more than a stated peak.

Caution should be exercised when applying these equations to conditions under which the specific volume of the fluid is large or where the pressure is very small. When the specific volume is large the kinetic energy may be appreciable and the enthalpy would have to be adjusted to allow for this (see for example Maker's article[1]). At low pressures where the pressure drop per return bend is of magnitude comparable with the pressure of the fluid the "lumping" of return bend losses and tube friction losses may not be a good approximation.

## About the Author

**A. Doll-Steinberg** is a process engineer for Foster Wheeler, Ltd., London, England. His duties include the process design of cracking and reforming plants. Doll-Steinberg attended Cambridge University where he graduated with first-class honors. He spent a year with Foster Wheeler Corp., New York, from January to December, 1957, having first joined Foster Wheeler, Ltd., London, in June, 1956.

Nevertheless for first estimates the equations will produce useful results even under these conditions.

### Using the Equations

**In the absence of steam**— $\left(\frac{\partial V}{\partial p}\right)^\circ_T$ and $\left(\frac{\partial H}{\partial p}\right)^\circ_T$ are determined by plotting specific volume and enthalpy of the fluid against pressure, at the temperature of outlet from the heater. The slopes of the curves in units of cu. ft./psi and Btu/lb./psi at the pressure corresponding to the outlet from the heater are the required quantities. $V_o$ the specific volume in units of cu. ft./lb. at the temperature and pressure of the heater outlet is calculated. $f$ is taken as 0.004 for a first trial and $F$ will be approximately 1.5. Having fixed $Q$, the radiant transfer rate and $w$ the flow rate per pass, Equation (30) is solved by trial and error or graphically for $D$, or having fixed $D$ the equation is solved for $w$. For a first trial the term containing $\left(\frac{\partial V}{\partial p}\right)^\circ_T$ may be neglected and a solution can then be obtained explicitly. From the value of $D$ or $w$ so obtained it is possible to determine a value of $f$ for the conditions at outlet using one of the published correlations, e.g., that of Lockhart & Martinelli.[4] Also a new value of $F$ may be estimated. If desired the calculation may then be repeated.

**In presence of steam**—The procedure is as before but since $\pi$ and $T$ at the outlet will be different for each steam quantity, new values of $\left(\frac{\partial V}{\partial \pi}\right)^\circ_T$, $\left(\frac{\partial H}{\partial \pi}\right)^\circ_T$, $V_o$ and $y_o$ will have to be used for each trial with a different steam quantity. Equation (34) is solved graphically for $S$; all the other quantities $w$, $D$ and $Q$, must be known.

### SYMBOLS USED

A — area of flow, inside tubes
c — factor of proportionality between increments of length of heater coil and increments of fluid enthalpy
$C_v$ — specific heat of vapor phase
$C_l$ — specific heat of liquid phase
D — inside diameter of tube, inches
f — friction factor, dimensionless
F — correction factor for actual length of heater coil to allow for pressure drop at return bends
H — enthalpy of fluid, Btu/lb.
$h_v$ — enthalpy of vapor phase
$h_l$ — enthalpy of liquid phase
L — equivalent length per pass of heater coil plus return bends
$L_r$ — equivalent length of one return bend
$L_c$ — actual length per pass of heater coil
w — mass flow per pass, lbs/hr.
n — number of return bends per pass
p — total pressure, psia
$\pi$ — partial pressure of oil, psia
Q — radiant transfer rate, figured on inside diameter of tubes, Btu/hr. ft.$^2$
s — steam quantity, moles per lb. of oil
T — temperature, °Rankine
V — specific volume of fluid, cu. ft./lb.
y — wt. fraction of fluid vaporised
M — molecular weight of oil vapor
Subscript, $_o$, refers to conditions at the heater outlet
$\lambda$ — latent heat

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# Heat Transfer Nomographs

## Part 3—Correction factor for film velocity and Reynolds number

## PART 4—Prandtl numbers for liquids and gases

## Part 5—Nusselt numbers for liquids and gases

**Jose Alvarez C. and Carlos Duhne**
Instituto de Investigaciones Industriales
Instituto Technologico de Monterrey
Monterrey, Mexico

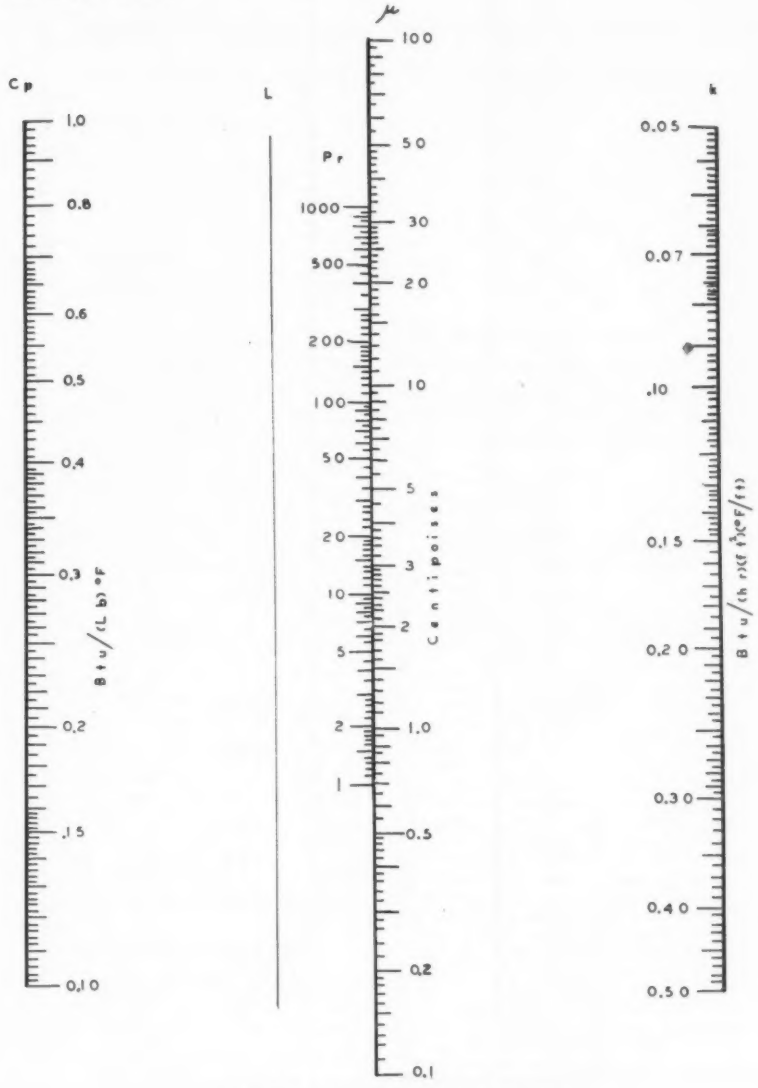


FIGURE 9—Prandtl number for gases.

PRANDTL NUMBERS which enter into most heat transfer calculations are time consuming. Nomographs 9 and 10, for determining this dimensionless factor, are real time-savers.

**Prandtl Number for Liquids**—Nomograph No. 9 solves the formula:

$$Pr = \frac{2.42\ C_p\ \mu'}{k}$$

Where: Pr, Prandtl number
$\mu'$, Viscosity, centipoises
$C_p$, Specific heat, Btu/lb. F.
k, Thermal conductivity, Btu/hr. ft. F.

Example: Find the Prandtl number for a liquid with a viscosity of 6.6 centipoises.

Where: $C_p$, 0.49 Btu/lb. F.
k, 0.078 Btu/h. ft. F.

Using Nomograph No. 9 the Prandtl number is found to be 101.

Key : $C_p$ — $\mu$ : L
L — k : Pr.

**Prandtl Number for Gases**—Nomograph No. 10 solves the formula:

$$Pr = \frac{2.42\ C_p\ \mu'}{k}$$

Where: Pr, Prandtl number
$\mu'$, Viscosity, centipoises
$C_p$, Specific heat, Btu/lb. F.
k, Thermal conductivity, Btu/hr. ft. F.

Example: Find the Prandtl for air at 50 F. with the following data: $C_p$, 0.24 Btu/lb. F. $\mu'$, 0.0182 centipoises; k, 0.014 Btu/hr. ft. F.

Solution: Using Nomograph No. 10 the Prandtl number is found to be 0.76.

Key : $C_p$ — $\mu$ : L
L — k : Pr.

See following page for Figure 10.

TO BE CONTINUED

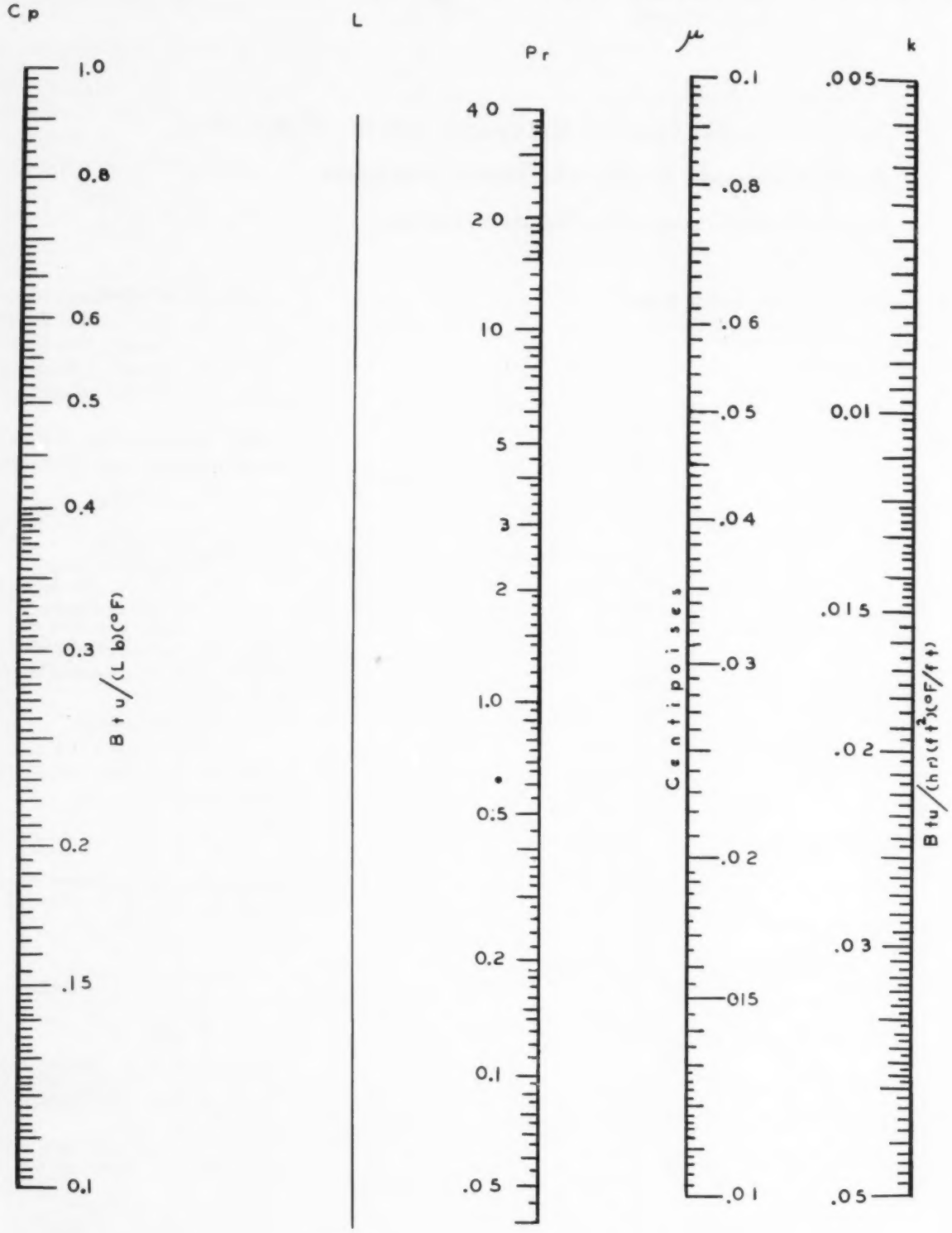


FIGURE 10—Prandtl number for liquids.

# How Computers Up Refinery Profits

**Here's how Champlin put inventory control of products and weight balances for all units on a computer for optimum profits**

**Lee A. Whitney**
Champlin Oil & Refining Co., Fort Worth

PROFIT IN a manufacturing operation is the difference between sales revenue and all costs of producing, distributing and selling the products. Optimum profit is simply maximum profit for any given set of conditions. Basically, then, the problem of optimizing profit reduces to one of maintaining the highest possible sales revenue and the lowest possible cost of operation. These two objectives, when achieved, give profit at its maximum or optimum for the then current conditions.

One of the more important jobs in cost control is material accounting. The value of crude oil, natural gasoline, and tetraethyl lead used daily at Champlin's Enid refinery is in excess of $100,000. It is obvious, therefore, that each barrel and pound of these materials must be carefully guarded if minimum costs are to be attained.

## INVENTORY CONTROL

In a normal 24-hour day between 400-500 separate tank gagings must be made in order to inventory process materials, finished goods, and transfers between units and to and from the refinery.

**Old Method.** This sizable job, until about one year ago, was done in conventional fashion. Yield clerks using tank tables and the gauging reports each day worked up a finished standard temperature inventory. Gaging information was available about 7 o'clock in the morning and usually by noon a complete inventory for the previous day was available. In general, it was between 2 and 5 o'clock in the afternoon before all transfers of material within the refinery had been completed. At best, therefore, it would be the following day before much use could be made of the information contained in these reports. This delay in information very often resulted in misoperation of units going unnoticed for as much as 48 hours. Expenses can mount rapidly under these circumstances.

**Champlin Oil & Refining Co.'s Enid, Oklahoma Refinery**

This completely revamped and modernized 30,000-bpd refinery includes—two crude units, fluid cat cracker, cat reformer, cat poly gasoline, HF alkylation, lube oil manufacturing and packaging, and asphalt manufacturing. Some 209 products range from LPG through aviation and motor fuel to road building materials.

Products are shipped by truck, rail and company owned pipe lines going south 85 miles to Oklahoma City and north 500 miles to Rock Rapids, Iowa, and by the Great Lakes pipe line system which receives products at the refinery.

Product distribution ranges south to Texas, north to the Canadian border, west to the Rocky Mountains and east to the Mississippi River. This entire marketing area is predominately agricultural. Market conditions, therefore, are often completely different than in the more heavily populated industrial areas.

**New Method.** Consequently, a method was needed to speed up the preparation of daily inventories and transfer schedules which form the working basis for all material accounting at the refinery. To do this, punch cards, as shown in Figure 7 were used. The use of the card was premised on elimination of tank tables and substitution of a barrel coefficient per foot of tank height. Notice that the card carries space for the product number,

the unit which is the particular cost center at the refinery, the tank number, the barrels per foot coefficient, the temperature coefficient of the particular material, temperature, gross barrels, BS&W, and columns for the corrected net barrels. At the left hand top of the card is a small box used by the gager to write in gage figures. These cards are prepunched with all necessary information except the actual gager's notation.

All of these pre-punched cards with the actual gages written thereon are forwarded to the office between 7 and 7:30 o'clock each morning. The gage information is punched into the medium scale computing punch for computation of the net barrels. When all cards have been processed, they are run through the tabulating machine and the completed printed inventory and transfer statement is available as shown in Figure 8.

The time saved by using cards for this purpose gets the completed inventory and transfer statement to the chief gager for checking by 8:30 o'clock in the morning. Copies of the checked statement are available to refinery accounting and operating groups by 9 to 10 o'clock each day. Not only has this method of handling inventory at the refinery made information available quickly but it has likewise greatly increased the reliability of the information. Thus, gross operating difficulties come to light quickly and steps may be taken to correct them properly.

### WEIGHT BALANCES

The information contained in this inventory and transfer report together with laboratory analyses and necessary meter readings throughout the refinery form the basis for the next most important job in material accounting—checking weight balances through each unit.

**Old Method.** Prior to changing our inventory procedure, material balances around individual units in the

**Programing a refinery for a computer requires operation and product streams broken down like this.**

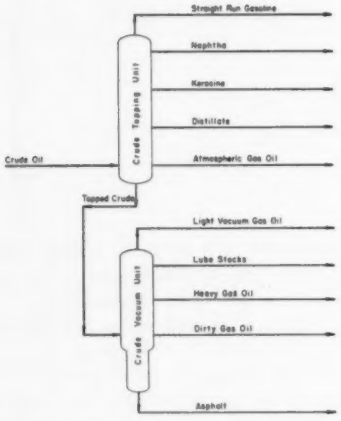


FIGURE 1—Atmospheric and vacuum crude units give these products.

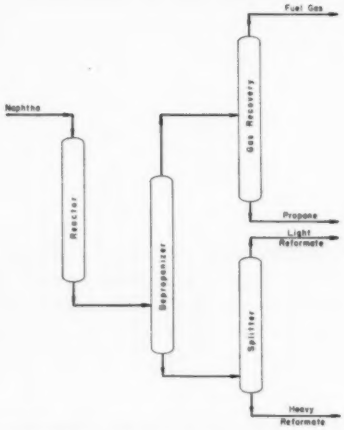


FIGURE 2—Reforming naphtha for gasoline blending stocks.

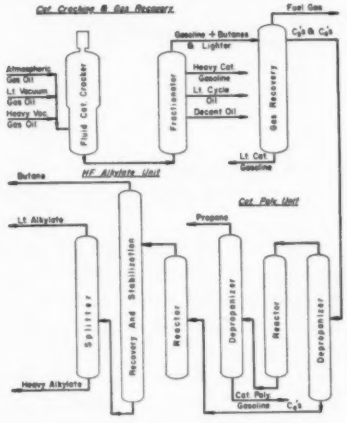


FIGURE 3—Cat cracking for gasoline gives cat poly and alkylation charge stocks.

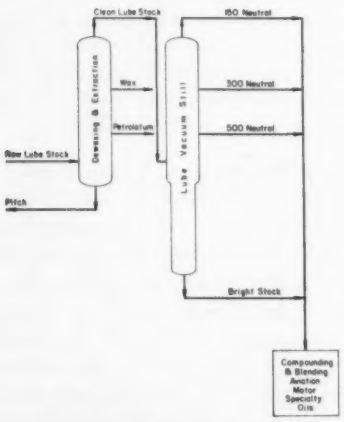


FIGURE 4—Lube stock from the crude unit is further refined into these products.

FIGURE 5—Here's how the light ends are blended into gasoline and jet fuels.

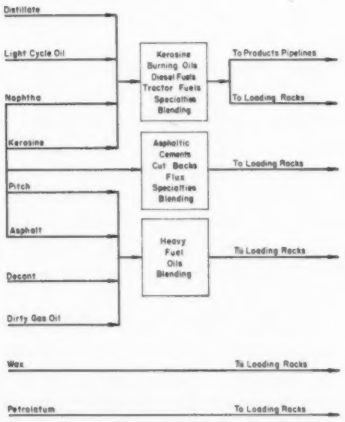


FIGURE 6—These stocks are blended into fuel oils and road building materials.

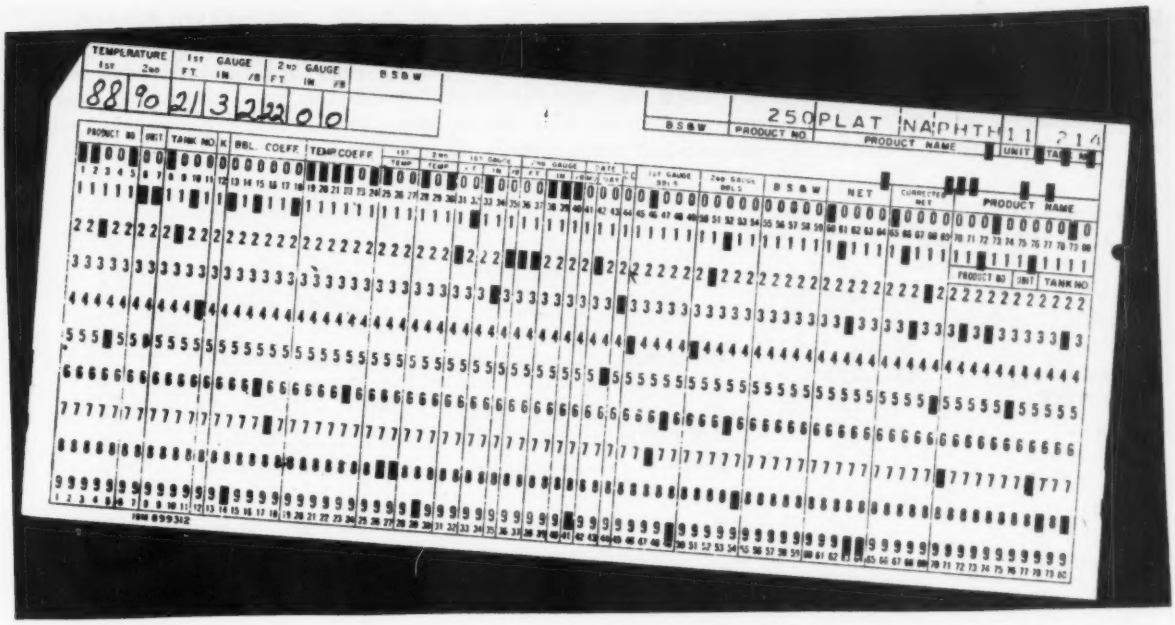


**FIGURE 7—Gager's record tank gages on pre-punched cards for punching and machine computation of inventory.**

refinery were usually confined to periodic spot checks unless obvious volumetric discrepancies showed in the daily inventory. Volumetric accounting in a refinery is most unsatisfactory since there are wide differences in gravity of the materials. The amount of effort, however, required to produce daily weight balances around each of the units was such that not much could be done with existing personnel even though the need was recognized.

**New Method.** With the acquisition of a medium sized, high speed digital computer at the refinery, however, it became possible to consider daily material balances. Accordingly, all of the information contained in the inventory transfer report plus, as noted above, supplementary meter and laboratory data are now fed to the computer each day to produce a material balance report of the form shown in Figure 9.

The data necessary for these computations goes to the office about ten o'clock in the morning. The computation is made directly on the form putting in necessary data and computing and then typing out the finished form shown. Notice a dollar value in the small box to the left middle portion of the form. This number represents a standard value for reformate in terms of its use in finished gasoline. So long as this value is slightly above or equal to our standard unit, the operations are satisfactory. Any deviation from satisfactory operations is indicated in an immediate decline in this value resulting in an indicated daily loss. We find this negative dollar figure is a much more effective flag than a simple statement showing a yield or quality loss.

The daily weight balance forms have been applied to the light end section of the refinery completely and to the overall refinery with all lubricating oil manufacturing combined. All of these forms, in general, are back at the refinery and in the hands of the accounting and operational people by noon. Use of punch cards for gauging reports and machines for necessary computation have, therefore, made a

Champlin Oil & Refining Co.

REFINERY
DAILY INVENTORY PRODUCTION & TRANSFERS

| PRODUCT NAME | PRODUCT NO. | UNIT | TANK NO. | BBL. COEFF | TEMP. COEFF | 1ST GAUGE FT | 1ST GAUGE IN | 1ST GAUGE /8 | 2ND GAUGE FT | 2ND GAUGE IN | 2ND GAUGE /8 | DATE MO | DATE DAY | 1ST TEMP | 2ND TEMP | 1ST GAUGE BBLS. | 2ND GAUGE BBLS. | B S & W | GROSS BBLS. | CORRECTED NET BBLS. | | CORRECTED NET BBLS. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ~~JET NAP~~ | ~~250~~ | ~~11~~ | ~~16~~ | ~~1916.71~~ | ~~.00060~~ | ~~3~~ | ~~00~~ | ~~0~~ | ~~20~~ | ~~04~~ | ~~0~~ | ~~9~~ | ~~9~~ | ~~96~~ | ~~96~~ | ~~2,085~~ | ~~6,379~~ | | ~~3,540~~ | ~~3,483~~ | ~~3~~ | |
| PLAT NAPHTH | 250 | 11 | 214 | 1916.71 | .00060 | 19 | 06 | 1 | 18 | 01 | 4 | 9 | 9 | 99 | 98 | 37,394 | 34,739 | | 2,655 | | 3 | 2,572 |
| ~~PLAT NAPHTH~~ | ~~250~~ | ~~11~~ | ~~214~~ | ~~1916.71~~ | ~~.00060~~ | ~~18~~ | ~~10~~ | ~~0~~ | ~~19~~ | ~~06~~ | ~~1~~ | ~~9~~ | ~~9~~ | ~~98~~ | ~~99~~ | ~~36,098~~ | ~~37,394~~ | | ~~1,296~~ | ~~1,244~~ | ~~3~~ | |
| PLAT NAPHTH | 250 | 11 | 215 | 1916.71 | .00060 | 6 | 03 | 0 | 5 | 07 | 2 | 9 | 9 | 92 | 92 | 11,979 | 10,741 | | 1,238 | | 3 | 1,214 |
| ~~PLAT NAPHTH~~ | ~~250~~ | ~~11~~ | ~~215~~ | ~~1916.71~~ | ~~.00060~~ | ~~5~~ | ~~07~~ | ~~2~~ | ~~5~~ | ~~07~~ | ~~2~~ | ~~9~~ | ~~9~~ | ~~92~~ | ~~92~~ | ~~10,741~~ | ~~10,741~~ | | | | ~~3~~ | |
| | | | | | | | | | | | | | | | | | | | | ~~4,727~~ | * | 3,786 |
| KERO 1 DIST | 400 | 11 | 12 | 171.00 | .00050 | 3 | 07 | 2 | 9 | 04 | 0 | 9 | 9 | 96 | 100 | 615 | 1,596 | | 981 | 960 | 3 | |
| KERO 1 DIST | 400 | 11 | 13 | 171.00 | .00050 | 4 | 09 | 0 | 16 | 01 | 2 | 9 | 9 | 96 | 102 | 812 | 2,753 | | 1,941 | 1,898 | 3 | |
| KERO 1 DIST | 400 | 11 | 50 | 252.74 | .00050 | 32 | 11 | 4 | 36 | 10 | 4 | 9 | 9 | 104 | 103 | 8,329 | 9,319 | | 990 | 973 | 3 | |
| KERO 1 DIST | 400 | 11 | 51 | 252.74 | .00050 | 1 | 00 | 0 | 2 | 11 | 4 | 9 | 9 | 104 | 104 | 253 | 746 | | 493 | 483 | 3 | |
| KERO 1 DIST | 400 | 11 | 132 | 152.13 | .00050 | 7 | 10 | 0 | | 10 | 0 | 9 | 9 | 96 | 96 | 1,191 | 126 | | 1,065 | | 3 | 1,046 |
| KERO 1 DIST | 400 | 11 | 132 | 152.13 | .00050 | 7 | 10 | 0 | | 10 | 0 | 9 | 9 | 96 | 96 | 1,191 | 126 | | 1,065 | | 3 | 1,046 |
| ~~KERO 1 DIST~~ | ~~400~~ | ~~11~~ | ~~133~~ | ~~152.13~~ | ~~.00050~~ | ~~7~~ | ~~08~~ | ~~0~~ | | ~~10~~ | ~~0~~ | ~~9~~ | ~~9~~ | ~~92~~ | ~~92~~ | ~~1,166~~ | ~~126~~ | | ~~1,040~~ | | ~~3~~ | ~~1,023~~ |

**FIGURE 8—This print-out shows complete refinery inventory and product transfers for previous 24-hours of operation.**

complete picture of operations available to refinery personnel in a reasonable time. This prompt material accounting has been invaluable in preventing unnecessary loss or contamination of products in the refinery.

## INCREASED PROFITS

If the refiner is to maintain his profits at optimum, he must determine rapidly the effect of any operations change on cost, product yield and sales revenue. The recognition of this prob-

24 Hrs. Ending
6 A.M. 6-1-58

| | TODAY | CUM. | RVP | CL + 3 cc |
|---|---|---|---|---|
| CHARGE: 3200 | | | | |
| Bbls. | 2976.0 | 65266 | | 39.0 |
| Lbs. | 788640.0 | | | |
| RECOVERY: | .0 | | | |
| Bbls. | 2853.0 | 60221 | 5.0 | 74.2 |
| Vol. % | 95.8 | 92.27 | | 89.4 |
| Vol. % Corr. | 99.3 | | | |
| Lbs. | 767457.0 | | | |
| Wt. % | | | | |

| FUEL GAS & LPG: | TOTAL | SEP. GAS. | STAB. GAS | GAS to F.C.C. |
|---|---|---|---|---|
| Cu. Ft. (M) | 1730.0 | 1623.0 | 107.0 | .0 |
| Btu's (MM) | .0 | 700.7 | 197.7 | .0 |
| Btu's Cu.Ft. | .0 | 431.7 | 1847.6 | .0 |
| Lbs. | 26508.0 | 17573.2 | 8934.8 | .0 |
| Bbls. C3" | .0 | .0 | .0 | .0 |
| C3 | 56.2 | 17.4 | 38.8 | .0 |
| C4" | .0 | .0 | .0 | .0 |
| IC4 | 5.5 | 3.9 | 1.6 | .0 |
| NC4 | 5.6 | 5.5 | .1 | .0 |
| C5+ | 5.5 | 5.5 | .0 | .0 |
| Total Bbls. | 72.8 | 32.3 | 40.5 | .0 |
| Cu.Ft. Bbls. | 581.2 | 545.3 | 35.9 | .0 |
| Wt.% | 3.3 | 2.2 | 1.1 | .0 |

| | |
|---|---|
| % Recovered | 100.675 |
| $/Value Bbl. | 4.419 |
| $ Variance | 32.736 |
| OK | |

| | | | | | |
|---|---|---|---|---|---|
| Cat. Life | 5.41 | | Water in Charge | | 0 |
| | | | Heater #1 Inlet | | 622 |
| | | | Dichloride in Reactor Chg. | | 0 |
| #1 Reactor In | 885 | | Recycle Rate MMSCF/D | | 30.9 |
| T | 71 | | $H_2HC$ Ratio | | 10 T |
| #2 Reactor In | 881 | | Density Rec. Gas | | .153 |
| T | 35 | | Density Stab. Gas | | 1.01 |
| #3 Reactor In | 876 | | $H_2S$ Recycle Gas | | – |
| T | 15 | | $H_2S$ Stab. Gas | | – |
| Total T | 121 | | Dist: | Plat. | Naphtha |
| | | | API | 52.2 | 55.1 |
| Com. Disch. P. | 518 | | IBP | 111 | 230 |
| Separator Press. | 452 | | 90% | 329 | 331 |
| Stab. Pressure | 250 | | EP | 399 | 390 |
| Clay Tower Press. | 77 | | % Over @ 212° | 11.0 | . |
| Amps. Comp. Motor | 67 | | Separator Inlet | | 87 |

Date of Analysis: Sep. Gas 5-28-58
Stab. Gas 5-28-58
Gas to FCC None

**FIGURE 9—Complete weight balance for the reformer is computed using inventory data, supplementary meter and laboratory data.**

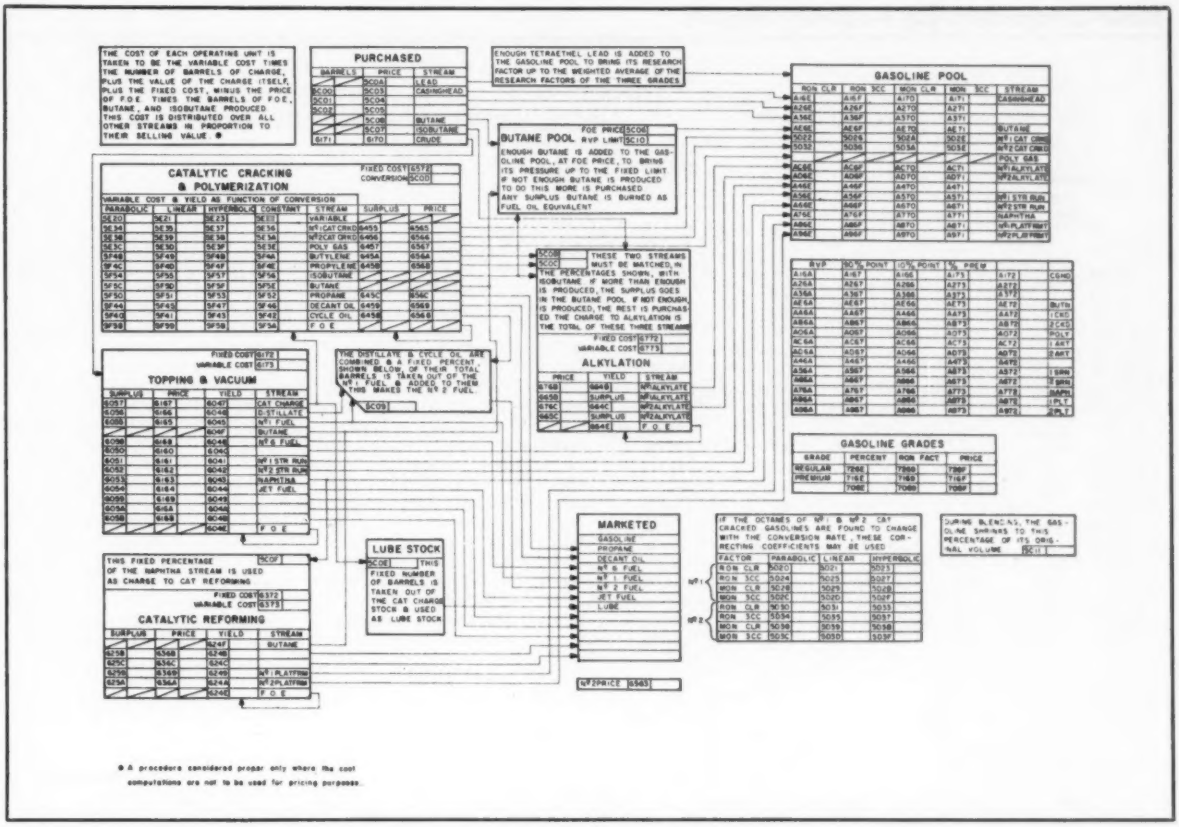


**FIGURE 10—Cost code sheet for data stored in computer. Constants are used in calculating minimum cost of refining operation.**

lem and the obvious need for speed were principal factors leading to our acquisition of a digital computer. The actual solution of this problem which we finally developed is completely unpretentious. Basically, it involves three major steps.

- A complete material accounting based on crude run.
- Development of the minimum cost of operations for specified conditions together with detailed unit cost of all products.
- Computation of the total gross margin as well as individual product margins.

**Step 1** in this computation follows in general the simplified flow diagrams (Figures 1-6). Crude oil is separated into the appropriate fractions for the particular crude run desired. Each of these fractions is then carried forward either to finished goods or to further processing.

Simultaneously with this material accounting, **Step 2,** a complete cost accounting for the particular set of conditions is made. This cost accounting follows the exact procedure used in developing our monthly statement. The dollar items of expense are separated into fixed and variable expenses which are then spread over each of the products in accordance with the material balance. During the course of these computations, the gas oil charged to the cat cracker is determined and the conversion level and the product distribution from the cat cracker are arbitrarily set in accordance with the excess capacity, if any, or with the need for burning oil.

For the reformer operation, an arbitrary severity level is chosen. The gasoline pool requirements for octanes, vapor pressure and lead are then examined to determine the quantity of naphtha which must be reformed in order to provide the lowest possible overall unit costs. Vapor pressure of the gasoline pool developed the computations is adjusted to meet the desired level by addition of the proper quantity of butane. All refinery butane is first used to meet this vapor pressure and in the event more butane is needed, it is purchased at the current delivered price in Enid.

In general, the over-all cost of refinery operation plots as a minimum point curve against naphtha charged to the reformer. Thus, the above computations actually determine the minimum point on this curve. The problem is so set up that three or four points on the curve may be calculated and a least squares parabolic correlation may be made on these points. The differential of this equation is then set equal to zero and the exact minimum point of the curve computed. On completion of all of these operations, a simple computation of gross and individual product margins is made.

Figure 10 illustrates the information upon which the complete computation is based. Actually this is a flow diagram of a sort indicating the areas in which information must be stored in the computer. While all of this information may be changed from time to time as costs vary or as individual unit product yields vary because of processing changes, very few of the inputs need

GASOLINE BLENDING - FINAL LINEAR PROGRAMMING TABLEAU

| Composition and Profit | | | 52. | 51. | 50. | 49. | 48. | 47. | 46. | 45. | 44. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 3.080 | 110. | .0033 | .01198 | .00000 | -.00002 | .00002 | -.00000 | .00002 | .00002 | .00002 | -.00000 |
| .000 | 51. | 28.0921 | .77966 | 1.00000 | .89830 | .68983 | .00000 | 1.00000 | .87627 | .94916 | .00000 |
| .000 | 33. | 1.3166 | .11014 | .00000 | .13177 | .07562 | -.00000 | .17242 | .17397 | .21033 | .00000 |
| 3.890 | 101. | .0712 | .00000 | .00000 | -.00000 | .01198 | .00000 | -.00002 | .00000 | -.00002 | .00000 |
| 3.610 | 102. | .0306 | -.00264 | .00000 | -.00122 | -.00372 | -.00000 | -.00002 | -.00148 | -.00061 | -.00000 |
| 1.140 | 109. | .0395 | .00000 | .00000 | -.00000 | .00000 | .00000 | .01198 | .00000 | .00000 | .00000 |
| 3.240 | 108. | .1495 | -.00002 | -.00000 | .00002 | -.00002 | .00000 | -.00002 | .01198 | -.00002 | .00000 |
| 1.450 | 107. | .0793 | .00000 | .00000 | .00002 | .00000 | .00000 | -.00002 | .00000 | .01198 | .00000 |
| .000 | 48. | 3.1179 | .22034 | .00000 | .10170 | .31017 | 1.00000 | -.00002 | .12373 | .05084 | .00000 |
| 3.510 | 105. | .0993 | .00000 | .00000 | .00002 | -.00002 | .00000 | .00000 | .00000 | -.00002 | .00000 |
| 3.980 | 104. | .1987 | .00000 | .00000 | -.00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 3.100 | 103. | .0319 | .00000 | .00000 | -.00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| 2.450 | 7. | .0523 | -.00000 | .00000 | -.00002 | .00002 | .00000 | -.00000 | -.00000 | -.00000 | -.00000 |
| 5.400 | 2. | .0021 | -.00000 | -.00000 | -.00002 | .00002 | -.00000 | -.00000 | .00002 | -.00000 | -.00000 |
| .000 | 44. | 2.0253 | .72511 | .00000 | -.16455 | .64156 | -.00000 | .93002 | .81496 | .88274 | 1.00000 |
| 4.430 | 8. | .6272 | -.00000 | -.00000 | -.00002 | .00002 | -.00000 | -.00000 | -.00000 | -.00000 | -.00000 |
| 4.050 | 10. | .3184 | .00000 | .00000 | .00002 | -.00002 | -.00000 | .00000 | .00000 | -.00002 | .00000 |
| 2.720 | 106. | .2892 | -.00002 | -.00000 | .01198 | -.00002 | .00000 | -.00002 | -.00002 | -.00002 | -.00000 |
| 1.040 | 120. | .0074 | -.00934 | .00000 | -.01076 | -.00827 | -.00000 | -.01198 | -.01050 | -.01137 | -.00000 |
| .000 | 34. | 4.4134 | -.03920 | .00000 | .08321 | -.01300 | -.00000 | .06590 | .08827 | -.03328 | .00000 |
| .000 | . | 7.2823 | .017658 | .000000 | .016998 | .024597 | -.000000 | .001198 | .022550 | .003347 | .000000 |

| Components | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. | 2. | 3. | 4. | 5. | 6. | 7. | 8. | 9. | 10. | 101. |
| -.57721 | -.00000 | .13931 | .86559 | -.86559 | -.41039 | .00000 | .00000 | -.24335 | -.00000 | .00000 |
| -.00000 | .00000 | .00002 | -.00002 | -.00002 | -.00002 | .00000 | .00000 | -.00002 | .00000 | .00000 |
| .97087 | -.00000 | .15915 | 1.37822 | 1.63234 | .67787 | .00000 | .00000 | .45328 | .00000 | .00000 |
| .24994 | -.00000 | -.00002 | -.00002 | -.00002 | .00000 | .00000 | .00000 | -.00002 | .00000 | 1.00000 |
| .0,498 | -.00000 | .01772 | .07831 | .11272 | .05698 | -.00000 | -.00000 | .06627 | .00000 | .00000 |
| -.00000 | -.00000 | .00000 | .00000 | .00000 | -.00000 | .00000 | .00000 | .24994 | .00000 | .00000 |
| .25789 | .00000 | -.52570 | .29791 | .33585 | .03793 | -.00000 | -.00000 | -.12265 | .00000 | -.00000 |
| .05440 | .00000 | .11873 | .12294 | .16710 | .06552 | -.00000 | .00000 | .04979 | .00000 | .00000 |
| .00002 | -.00000 | -.00002 | -.00000 | -.00000 | .00002 | .00000 | .00000 | -.00000 | .00000 | .00000 |
| .00002 | -.00000 | -.00002 | -.00002 | .24994 | -.00002 | .00000 | .00000 | -.00002 | .00000 | .00000 |
| -.00000 | -.00000 | .00000 | .24994 | .00000 | -.00000 | .00000 | .00000 | -.00000 | .00000 | .00000 |
| -.00000 | -.00000 | .24994 | .00000 | .00000 | -.00000 | .00000 | .00000 | -.00000 | .00000 | .00000 |
| -.21762 | -.00000 | -.47504 | -.49190 | -.66853 | -.26216 | 1.00000 | .00000 | -.19922 | -.00000 | .00000 |
| -.05995 | 1.00000 | -.07091 | -.31332 | -.45096 | -.22797 | .00000 | .00000 | -.26512 | -.00000 | -.00000 |
| -.00002 | -.00000 | .00002 | -.00002 | -.00002 | -.00002 | .00000 | .00000 | -.00002 | -.00000 | .00000 |
| -1.03181 | -.00000 | 2.10332 | -1.19196 | -1.34369 | -.15176 | .00000 | 1.00000 | .49069 | -.00000 | -.00000 |
| 2.30939 | -.00000 | -.55737 | 2.99719 | 3.46318 | 1.64191 | .00000 | .00000 | .97365 | 1.00000 | .00000 |
| .00002 | -.00000 | -.00002 | -.00002 | -.00002 | .24994 | -.00000 | -.00000 | -.00002 | .00000 | -.00000 |
| .00000 | -.00000 | -.00002 | .00000 | .00002 | .00002 | -.00000 | .00000 | .00002 | -.00000 | .00000 |
| 3.36559 | -.00000 | -.57143 | 4.15100 | 4.74359 | 3.17545 | .00000 | .00000 | 1.12889 | .00000 | -.00000 |
| .318172 | .000000 | .970349 | .814817 | 1.528837 | 1.043514 | .000000 | .000000 | 2.746759 | .000000 | .000000 |

| Components in Premium | Components in Regular | |
|---|---|---|
| $X_1$ = Natural | $X_{101}$ = Natural | $X_{25}$ = Premium Quantity |
| $X_2$ = Butane | $X_{102}$ = Butane | $X_{26}$ = Premium Reid Vapor Pressure |
| $X_3$ = Cat Poly | $X_{103}$ = Cat Poly | $X_{27}$ = Premium Lead |
| $X_4$ = Light Straight Run | $X_{104}$ = Light Straight Run | $X_{28}$ = Premium Motor Octane Number |
| $X_5$ = Heavy Straight Run | $X_{105}$ = Heavy Straight Run | $X_{31}$ = Regular Quantity |
| $X_6$ = Platformate | $X_{106}$ = Platformate | $X_{32}$ = Regular Reid Vapor Pressure |
| $X_7$ = Alkylate | $X_{107}$ = Alkylate | $X_{33}$ = Regular Lead |
| $X_8$ = Light Cat | $X_{108}$ = Light Cat | $X_{34}$ = Regular Motor Octane Number |
| $X_9$ = Heavy Cat | $X_{109}$ = Heavy Cat | $X_{41}$ = Total Cat Poly Available |
| $X_{10}$ = Special Natural | $X_{110}$ = Special Natural | $X_{42}$ = Total Light Straight Run Available |

Slack Vectors

| 43. | 42. | 41. | 25. | 26. | 27. | 28. | 31. | 32. | 33. | 34. |
|---|---|---|---|---|---|---|---|---|---|---|
| -.00000 | -.00002 | .00002 | .00456 | -.00346 | -.04668 | .00403 | -.00002 | -.00002 | -.00000 | .00000 |
| .88814 | .82542 | .95763 | -1.01695 | .35356 | -.00002 | -.00002 | -1.01695 | 1.41458 | .00000 | .00000 |
| .08530 | .08534 | .21222 | -.22865 | .08971 | .21188 | .01341 | -.18350 | .31526 | 1.00000 | .00000 |
| -.00002 | -.00002 | -.00002 | .00000 | -.00002 | -.00002 | .00002 | -.00000 | -.00002 | .00000 | .00000 |
| -.00134 | -.00209 | -.00050 | .00078 | .00009 | .00687 | .00085 | -.00020 | .01695 | -.00000 | .00000 |
| .00000 | -.00000 | .00000 | -.00000 | .00000 | -.00000 | -.00000 | -.00000 | .00000 | .00000 | .00000 |
| -.00002 | .00002 | -.00002 | -.01216 | .00400 | .01903 | -.02042 | .00002 | -.00002 | .00000 | -.00000 |
| .00000 | -.00002 | .00000 | -.00536 | .00362 | .02077 | .01555 | .00002 | .00000 | .00000 | .00000 |
| .11186 | .17458 | .04237 | .01695 | -.35356 | -.00002 | -.00002 | .01695 | -1.41458 | .00000 | .00000 |
| .01198 | -.00002 | .00000 | -.00002 | -.00002 | -.00002 | -.00002 | .00002 | -.00002 | .00000 | .00000 |
| .00000 | .01198 | .00000 | -.00000 | .00000 | -.00000 | -.00000 | -.00000 | .00000 | .00000 | .00000 |
| .00000 | -.00000 | .01198 | -.00000 | .00000 | -.00000 | -.00000 | -.00000 | .00000 | .00000 | .00000 |
| .00002 | .00000 | -.00002 | .02141 | -.01448 | -.08311 | -.06219 | .00000 | -.00000 | .00000 | .00000 |
| .00002 | .00002 | .00002 | -.00391 | .01662 | -.02750 | -.00340 | -.00002 | -.00000 | -.00000 | -.00000 |
| .82599 | .76767 | .89063 | -.94579 | .32883 | -.00002 | -.00002 | -.94579 | 1.31560 | -.00000 | .00000 |
| -.00000 | .00000 | -.00000 | .04868 | -.01598 | -.07611 | .08171 | .00000 | -.00000 | -.00000 | -.00000 |
| -.00002 | -.00002 | .00000 | -.01823 | .01385 | .18674 | -.01611 | .00002 | -.00002 | .00000 | .00000 |
| -.00002 | -.00002 | -.00002 | .00002 | .00002 | -.00002 | -.00002 | .00002 | .00002 | .00000 | -.00000 |
| -.01064 | -.00989 | -.01147 | .01219 | -.00424 | .00002 | .00002 | .01219 | -.01695 | -.00000 | .00000 |
| -.00468 | -.00732 | .19592 | -.08968 | .03069 | .23512 | -.20680 | -1.07307 | .05933 | .00000 | 1.00000 |
| .026150 | .029851 | .023378 | 4.155457 | .042952 | .039760 | .097823 | 1.011939 | .043559 | -.000000 | .000000 |

| 102. | 103. | 104. | 105. | 106. | 107. | 108. | 109. | 110. | 120. |
|---|---|---|---|---|---|---|---|---|---|
| .00000 | .00000 | .00000 | .00000 | -.00000 | .00000 | .00000 | .00000 | 1.00000 | .00000 |
| .00000 | .00000 | .00000 | .00000 | .00000 | -.00000 | .00000 | -.00000 | .00000 | -.00000 |
| .00000 | .00000 | .00000 | .00000 | -.00000 | -.00000 | .00000 | -.00000 | .00000 | -.00000 |
| .00000 | .00000 | .00000 | .00000 | .00000 | -.00000 | .00000 | -.00000 | -.00000 | -.00000 |
| 1.00000 | .00000 | .00000 | .00000 | .00000 | -.00000 | .00000 | -.00000 | -.00000 | -.00000 |
| .00000 | .00000 | .00000 | .00000 | .00000 | -.00000 | .00000 | 1.00000 | -.00000 | -.00000 |
| -.00000 | -.00000 | -.00000 | -.00000 | .00000 | -.00000 | 1.00000 | -.00000 | -.00000 | -.00000 |
| .00000 | .00000 | .00000 | .00000 | .00000 | -.00000 | .00000 | -.00000 | -.00000 | -.00000 |
| .00000 | .00000 | .00000 | .00000 | -.00000 | -.00000 | .00000 | -.00000 | .00000 | -.00000 |
| .00000 | .00000 | .00000 | 1.00000 | .00000 | -.00000 | .00000 | -.00000 | -.00000 | -.00000 |
| .00000 | .00000 | 1.00000 | .00000 | .00000 | -.00000 | .00000 | -.00000 | -.00000 | -.00000 |
| .00000 | 1.00000 | .00000 | .00000 | .00000 | -.00000 | .00000 | -.00000 | -.00000 | -.00000 |
| .00000 | .00000 | .00000 | .00000 | .00000 | -.00000 | .00000 | -.00000 | .00000 | -.00000 |
| -.00000 | -.00000 | -.00000 | -.00000 | -.00000 | .00000 | -.00000 | .00000 | .00000 | .00000 |
| .00000 | .00000 | .00000 | .00000 | -.00000 | .00000 | .00000 | .00000 | .00000 | .00000 |
| -.00000 | -.00000 | -.00000 | -.00000 | -.00000 | .00000 | -.00000 | .00000 | .00000 | .00000 |
| .00000 | .00000 | .00000 | .00000 | -.00000 | -.00000 | .00000 | -.00000 | -.00000 | -.00000 |
| -.00000 | -.00000 | -.00000 | -.00000 | 1.00000 | -.00000 | -.00000 | -.00000 | -.00000 | -.00000 |
| .00000 | .00000 | .00000 | .00000 | -.00000 | .00000 | .00000 | -.00000 | -.00000 | 1.00000 |
| -.00000 | -.00000 | -.00000 | -.00000 | -.00000 | -.00000 | -.00000 | -.00000 | -.00000 | -.00000 |
| .000000 | .000000 | .000000 | .000000 | .000000 | .000000 | .000000 | .000000 | .000000 | .000000 |

Slack Vectors

$X_{43}$ = Total Heavy Straight Run Available
$X_{44}$ = Processing Relationship between Naphtha and Platformate
$X_{45}$ = Total Alkylate Available
$X_{46}$ = Total Light Cat Available
$X_{47}$ = Total Heavy Cat Available
$X_{48}$ = Total Butane Available
$X_{49}$ = Total 19.3# Natural Available
$X_{50}$ = Total Platformate Available
$X_{51}$ = Total Naphtha Available
$X_{52}$ = Total 14# Natural Available

**FIGURE 11—Print-out tableau of a 22 x 46 matrix for gasoline blending computation. Many alternate solutions to blending problems are shown along with results of present blending method.**

be changed for any given problem. On completion of any computation, a deck of cards is punched and it is a matter of only a few minutes to reinstate the problem making any changes necessary. The time requirement to reach a minimum cost of operation for any given reformer severity and crude run is approximately 15 minutes. Therefore, it is an easy matter to pinpoint minimum operating costs.

The margin computation carried simultaneously is of extreme value. The marketing area is predominately agricultural and consequently product demand varies tremendously with seasonal agricultural requirements. Very often changing demands for products may be met by varying product distribution in the refinery. Quite often this may result in increased operating costs, but with a considerable increase in gross operating profit. The marginal computation permits examination of this possibility for any given set of circumstances.

**About the Author**

**Lee A. Whitney** is vice president of manufacturing and sales for Champlin Oil & Refining Co., Fort Worth, Texas. He received a B.A. degree from the University of Rochester in 1935, and joined U. S. Industrial Chemicals, Inc. that year as a chemist. He was assistant superintendent of petrochemical pilot plants for Industrial Alcohol Co. from 1941-42, and superintendent of petrochemical pilot plants for U. S. Industrial Chemicals from 1942-44. He also served as assistant to the director of technical development, acting director of technical development, and coordinator of the office of Chemical Technology Development for that company. Whitney then joined Chicago Corp. as director of chemical research and development. He went to Champlin in 1954.

## GASOLINE BLENDING

As mentioned briefly above, this whole computation not only produces a material balance, economic balance, and margins of profit, but likewise shows in detail the composition of the total gasoline pool including lead required to meet octanes. The actual blending of these gasoline stocks into two or more gasoline pools is a complicated procedure. All of the gasoline stocks produced each day must be used in blending the required premium and regular gasolines. All of the specifications for distillations, octanes, vapor pressure and so forth must be met. Tetraethyl lead used in meeting octane requirements must be held to a minimum quantity consistent with the requirement developed for the total pool. To check procedure on blending, a linear programming computation is used.

In setting up these problems, restraining equations express the various quantity and quality requirements of each gasoline. These restraints include minimum research and motor octane numbers, maximum vapor pressure and cc of lead. The matrix size involved in these computations in general runs about 22 x 46. Solution time on the computer ranges from 1.5-3.0 hours. In the final typeout of information from these problems, not only an optimum solution but also a complete final tableau print-out is taken. This complete tableau is extremely valuable in that it gives many alternate solutions showing clearly the changes in compositions of gasoline blends which will result from unit changes in the restraints. Additionally, it gives a clear picture of the effect on profit should it be decided to use a material say in premium gasoline which was not used in the optimum solution. Figure 11 is a replica of a final print-out on this problem.

## FUTURE PLANS

Beyond its use in checking gasoline blending, also a planned evaluation of all gasoline stocks using linear programming techniques is being conducted. In these studies, it is assumed that any or all of the gasoline stocks could be bought on the open market at manufacturing cost. It is further assumed that only as much of any stock as is desirable might be used. This, of course, is far from what must be done in practice since all gasoline stocks produced each day must be used. However, this kind of study produces an entirely different picture of the value of many refinery stocks. It is believed that substantial improvements in utilization of some of the stocks may result from these studies. Actually, they have already proven of considerable value in the study of natural gasoline utilization and reformer operation.

Recently, this same linear programming technique has been used in the study of a planned marketing expansion. This study involved both the acquisition of business by purchase and the expansion of existing business through construction of new outlets.

Inventories maintained in five terminals located on our pipeline system plus the Enid refinery represent working capital which is relatively unavailable. Therefore, a computation has been developed which permits scheduling of deliveries into the pipe line system in such a manner that inventories may be held within desired limits for any particular terminal against any sales estimate.

An attempt has been made to cover some of the more important problems associated with maintenance of optimum profits with particular emphasis on crude oil refining and marketing. While very substantial use of high speed computing equipment is made, such equipment was not emphasized in this discussion. These machines are, in our opinion, simply a means to an end. The lack of computing equipment is no reason to ignore problems which exist in refining or in any other industry. Once the problem is recognized and a feasible method of solution developed, then high speed computation may or may not be worthwhile. If time is a factor in developing the information, then it is a rather simple matter to code the problem for machine solution. However, all of the work described here was placed on computing facilities in prompt fashion with no increase in personnel. Champlins' computing facilities are run as an open shop and everyone with a problem is encouraged to try his hand at using the computer. Those who are genuinely interested learn quickly to code problems in machine language.

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# Estimate Latent Heats Rapidly

**All you need to know is the critical pressure and the normal latent heat. This correlation shows excellent agreement with experimental data**

**Chien Chi Li and Lawrence N. Canjar**
Carnegie Institute of Technology
Pittsburgh, Penn.

THERE HAS BEEN CONSIDERABLE INTEREST recently in the more accurate correlation of the P-V-T and related thermodynamic properties of chemical compounds using reduced properties as parameters. An example of one of the successful correlations is the work of Lydersen, Greenkorn and Hougen[9]. However, the important quantity, the latent heat of vaporization has been to some extent, neglected or left to be calculated from estimated saturated vapor and liquid volumes in conjunction with vapor pressure data through the Clapeyron equation. A direct method of estimating heats of vaporization as a function of temperature or pressure is certainly desirable and possible.

The theoretical background for the proposed correlation has as its basis the Clapeyron equation

$$\frac{dP}{dT} = \frac{\Delta H}{T\Delta V} \qquad (1)$$

Writing volumes in terms of pressure, temperature and compressibility factors,

$$\Delta V = \Delta Z \frac{RT}{P} \qquad (2)$$

Equation (1) can be rewritten in the form

$$\frac{d\ln P}{d\,1/T} = -\frac{\Delta H}{R\Delta Z} \qquad (3)$$

Waring[19] studied the right hand term of Equation (3) for a large number of substances and found that when it was plotted versus reduced temperature a curve of the same general shape was always obtained. Using the parameters of Lydersen, Greenkorn and Hougen it might be expected that the ratio of heat of vaporization to compressibility factor change on vaporization can be represented as a function of reduced temperature and the critical compressibility factor.

$$\frac{\Delta H}{\Delta Z} = f\,(Tr, Z_c) \qquad (4)$$

Further since the change in compressibility factor on vaporization is known to be a function of reduced temperature and critical compressibility factor from the work of Lydersen, Greenkorn and Hougen, Equation (4) can also be written as

$$\Delta H = f'\,(Tr, Z_c) \qquad (5)$$

Again referring to the same work, it is known that reduced vapor pressure is a function of reduced temperature and critical compressibility factor and therefore Equation (5) has an alter-

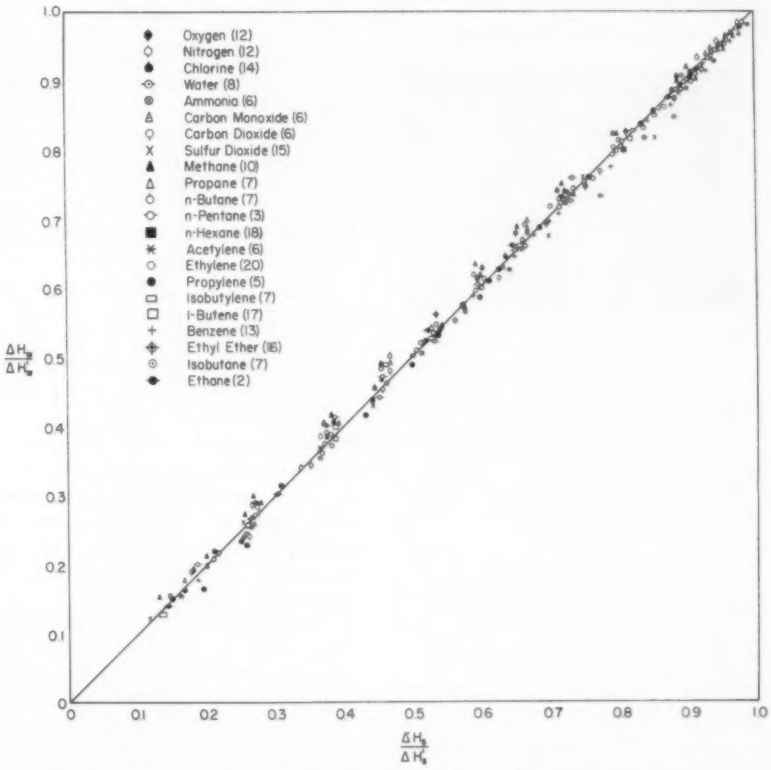


**FIGURE 1—This is a comparison of literature values for latent heat of vaporization with values calculated by equation (10). Calculated values are given by solid line.**

nate form

$$\Delta H = \ominus (Pr, Z_c) \qquad (6)$$

If the ratio of the heats of vaporization for two different substances is considered at the same reduced temperature or reduced pressure it could be expected that some simple function might result.

$$\frac{\Delta H_2}{\Delta H_2} = \frac{f'(T_r, Z_{c_1})}{f'(T_r, Z_{c_2})} \qquad (7)$$

or

$$\frac{\Delta H_1}{\Delta H_2} = \frac{\ominus (P_r, Z_{c_1})}{\ominus (P_r, Z_{c_2})} \qquad (8)$$

The literature was searched for a variety of compounds for which heats of vaporization were available and in order to find the form of the functions given by equations (7) and (8) the heat of vaporization of each substance was plotted against the heat of vaporization of water at the same reduced temperature or reduced pressure. Water was chosen as the reference compound since the most accurate information was available for its heat of vaporization. For a large number of polar and non-polar compounds, particularly in regions where accurate information is available, straight lines were obtained. Better results were obtained using reduced pressures than using reduced temperatures. It can be concluded, therefore, that equation (8) can be written

$$\frac{\Delta H_1}{\Delta H_2} = m \qquad (9)$$

where m is a constant which is a function of the particular pair of compounds considered.

Since most experimental determinations of heats of vaporization are made at the normal boiling point this is the point which is known with the greatest certainty.

The constant m can be readily obtained, therefore, by dividing the heat of vaporization at the normal boiling point for the compound in question by the heat of vaporization of a reference compound, which is water in this work, at a reduced pressure corresponding to one atmosphere for the compound in question or one atmosphere divided by the critical pressure of the compound. Equation (9) becomes

$$\Delta H_{s(Pr)} = \frac{\Delta H_s'}{\Delta H_w'} \Delta H_{w(Pr)} \qquad (10)$$

The heat of vaporization of a compound can be estimated for any pressure at which vapor and liquid phases can coexist provided the critical pressure and the heat of vaporization at the normal boiling point or any pressure are known. Table I gives the heat of vaporization of water as a function of reduced pressure.

Figure 1 shows graphically the agreement between values of heat of vaporization available in the literature for twenty one compounds with values calculated by use of Equation 10. Table 2 gives numerical comparison of literature values with calculated values for the same compounds. In some instances the agreement seems poor. However upon close examination poor agreement may not necessarily be ascribed to failure on the part of the correlation.

Most of the heat of vaporization information in the literature is obtained indirectly from the Clapeyron equation which is given as Equation (1) in this paper. Two measurements are required before the Clapeyron equation can be successfully employed to calculate heats of vaporization.

**Table 1**
**Heat of Vaporization of Water as a Function of Reduced Pressure**

| Reduced Pressure, P/Pc | ΔH, BTU/lb. | Reduced Pressure, P/Pc | ΔH, BTU/lb. |
|---|---|---|---|
| 0.00005 | 1067.2 | 0.53 | 520.0 |
| 0.0001 | 1056.0 | 0.54 | 514.5 |
| 0.0005 | 1026.9 | 0.55 | 508.5 |
| 0.001 | 1011.5 | 0.56 | 503.0 |
| 0.005 | 967.4 | 0.57 | 496.5 |
| 0.01 | 942.2 | 0.58 | 490.0 |
| 0.02 | 911.7 | 0.59 | 484.0 |
| 0.03 | 890.1 | 0.60 | 478.0 |
| 0.04 | 873.8 | 0.61 | 472.0 |
| 0.05 | 858.2 | 0.62 | 465.6 |
| 0.06 | 846.5 | 0.63 | 460.0 |
| 0.07 | 833.8 | 0.64 | 453.6 |
| 0.08 | 823.0 | 0.65 | 447.5 |
| 0.09 | 813.2 | 0.66 | 441.5 |
| 0.10 | 790.0 | 0.67 | 435.5 |
| 0.20 | 721.2 | 0.68 | 429.5 |
| 0.21 | 714.0 | 0.69 | 422.5 |
| 0.22 | 707.5 | 0.70 | 414.5 |
| 0.23 | 700.4 | 0.71 | 408.5 |
| 0.24 | 695.0 | 0.72 | 402.4 |
| 0.25 | 688.0 | 0.73 | 396.5 |
| 0.26 | 682.5 | 0.74 | 390.0 |
| 0.27 | 676.0 | 0.75 | 382.6 |
| 0.28 | 670.0 | 0.76 | 375.6 |
| 0.29 | 663.5 | 0.77 | 368.0 |
| 0.30 | 656.6 | 0.78 | 360.8 |
| 0.31 | 650.0 | 0.79 | 353.2 |
| 0.32 | 645.0 | 0.80 | 345.0 |
| 0.33 | 639.0 | 0.81 | 337.5 |
| 0.34 | 632.5 | 0.82 | 239.5 |
| 0.35 | 626.5 | 0.83 | 322.0 |
| 0.36 | 622.0 | 0.84 | 314.0 |
| 0.27 | 615.2 | 0.85 | 306.0 |
| 0.38 | 609.0 | 0.86 | 298.0 |
| 0.39 | 603.0 | 0.87 | 289.5 |
| 0.40 | 597.0 | 0.88 | 280.0 |
| 0.41 | 591.0 | 0.89 | 269.5 |
| 0.42 | 585.0 | 0.90 | 258.5 |
| 0.43 | 578.7 | 0.91 | 248.0 |
| 0.44 | 573.0 | 0.92 | 237.5 |
| 0.45 | 567.5 | 0.93 | 229.5 |
| 0.46 | 562.0 | 0.94 | 217.0 |
| 0.47 | 555.0 | 0.95 | 200.0 |
| 0.48 | 549.5 | 0.96 | 181.2 |
| 0.49 | 543.5 | 0.97 | 161.0 |
| 0.50 | 537.7 | 0.98 | 136.5 |
| 0.51 | 532.0 | 0.99 | 106.0 |
| 0.52 | 526.0 | 1.00 | 0.0 |

These are the complete vapor pressure curve and saturated liquid and vapor volumes. Methane is one substance which shows marked disagreement with the correlation. However as pointed out by Canjar[4], values for the saturated vapor volumes for methane are not only uncertain but experimental values are believed to be incorrect. Since heats of vaporization were calculated using these uncertain saturated vapor volumes, the deviations from the correlation presented here may merely reflect these uncertainties.

Further, since the derivative of the vapor pressure is required for use with the Clapeyron equation extremely accurate data on vapor pressure is necessary. The uncertainty in vapor pressure measurements increases as the pressure approaches the critical pressure. It is significant therefore that most cases of discrepancy between measured and calculated values of heats of vaporization occur at pressures approaching the critical pressure. It is not suggested here that values calculated using Equation (10) are superior to values found in the literature. However,


## About the Authors

**Chien Chi Li** **Canjar**

**Chien Chi Li** is a graduate student at Carnegie Institute of Technology. He holds a B.S. degree from Ordnance Engineering College, and a M.S. degree from the Carnegie Institute of Technology, which he received in September, 1958. He formerly worked with explosives and adhesives for the Ordnance Research Institute, China.

**Dr. Lawrence N. Canjar** is an associate professor at Carnegie Institute of Technology, where he is engaged in both teaching and research. A holder of B.S., M.S., and D.Sc. degrees from Carnegie Tech, Dr. Canjar has worked as a consultant for L'Air Liquide, Montreal, Canada; as a consultant for American Petroleum Institute Research Project number 44; and a partner in Associated Chemical Engineers of Pittsburgh.

**Table 2**

| Pr | ΔH BTU/lb Literature | ΔH BTU/lb Calculated | Difference |
|---|---|---|---|
| **Methane** [10] | | | |
| 0.02 | 220.0 | 220.4 | — 0.4 |
| 0.04 | 213.0 | 211.0 | 2.0 |
| 0.06 | 207.6 | 204.6 | 3.0 |
| 0.08 | 202.5 | 199.0 | 2.5 |
| 0.10 | 198.0 | 193.5 | 4.5 |
| 0.2 | 181.5 | 174.5 | 7.0 |
| 0.4 | 152.7 | 143.4 | 9.3 |
| 0.6 | 125.0 | 115.3 | 9.7 |
| 0.8 | 91.0 | 82.5 | 8.5 |
| 1.0 | 0.0 | 0.0 | 0.0 |
| **Propane** [7] | | | |
| 0.02 | 184.6 | 185.3 | —0.7 |
| 0.04 | 178.2 | 177.5 | 0.7 |
| 0.06 | 174.0 | 172.0 | 2.0 |
| 0.08 | 170.0 | 167.4 | 2.6 |
| 0.10 | 166.8 | 162.5 | 4.3 |
| 0.2 | 151.0 | 146.9 | 4.1 |
| 0.4 | 124.0 | 120.6 | 3.4 |
| 0.6 | 99.5 | 97.0 | 2.5 |
| 0.8 | 71.0 | 69.3 | 1.7 |
| 1.0 | 0.0 | 0.0 | 0.0 |
| **Isobutane** [7] | | | |
| 0.02 | 160.0 | 160.0 | 0.0 |
| 0.04 | 153.0 | 153.0 | 0.0 |
| 0.06 | 148.0 | 148.5 | — 0.5 |
| 0.08 | 144.0 | 144.3 | — 0.3 |
| 0.10 | 140.0 | 140.2 | — 0.2 |
| 0.2 | 125.5 | 126.5 | — 1.0 |
| 0.4 | 103.5 | 104.1 | — 0.6 |
| 0.6 | 82.5 | 83.7 | — 1.2 |
| 0.8 | 59.0 | 59.8 | — 0.8 |
| 1.0 | 0.0 | 0.0 | 0.0 |
| **n-Butane** [7] | | | |
| 0.02 | 168.4 | 168.4 | 0.0 |
| 0.04 | 161.0 | 161.0 | 0.0 |
| 0.06 | 156.5 | 156.0 | 0.5 |
| 0.08 | 152.5 | 151.8 | 1.3 |
| 0.10 | 149.0 | 147.5 | 1.5 |
| 0.2 | 135.3 | 133.3 | 2.0 |
| 0.4 | 111.0 | 109.5 | 0.5 |
| 0.6 | 89.0 | 88.2 | 0.8 |
| 0.8 | 65.0 | 64.0 | 1.0 |
| 1.0 | 0.0 | 0.0 | 0.0 |
| **Propylene** [5] | | | |
| 0.02 | 189.2 | 189.3 | — 0.1 |
| 0.04 | 181.0 | 181.0 | 0.0 |
| 0.06 | 175.5 | 175.5 | 0.0 |
| 0.08 | 171.0 | 170.8 | 0.2 |
| 0.10 | 167.0 | 165.9 | 1.1 |
| 0.2 | 150.0 | 149.8 | 0.2 |
| 0.4 | 124.5 | 123.3 | 1.2 |
| 0.6 | 103.0 | 99.3 | 3.7 |
| 0.8 | 73.0 | 70.8 | 2.2 |
| 1.0 | 0.0 | 0.0 | 0.0 |
| **Ethyl Ether** [16] | | | |
| 0.02 | 157.5 | 157.8 | — 0.3 |
| 0.04 | 151.0 | 151.0 | 0.0 |
| 0.06 | 146.0 | 146.3 | — 0.3 |
| 0.08 | 142.0 | 142.3 | — 0.3 |
| 0.10 | 138.4 | 138.0 | — 0.4 |
| 0.2 | 126.0 | 125.0 | 1.0 |
| 0.4 | 105.0 | 102.7 | 2.3 |
| 0.6 | 84.5 | 82.5 | 2.0 |
| 0.8 | 60.5 | 59.0 | 1.5 |
| 1.0 | 0.0 | 0.0 | 0.0 |
| **Ethane** [2] | | | |
| 0.02 | 210.5 | 210.3 | 0.2 |
| 0.04 | 202.0 | 201.6 | 0.4 |
| 0.06 | 195.5 | 195.3 | 0.2 |
| 0.08 | 190.5 | 189.9 | 0.6 |
| 0.1 | 186.0 | 184.5 | 1.5 |
| 0.2 | 169.0 | 166.5 | 2.5 |
| 0.4 | 141.0 | 137.0 | 4.0 |
| 0.6 | 115.0 | 110.0 | 5.0 |
| 0.8 | 80.0 | 78.7 | 1.3 |
| 1.0 | 0.0 | 0.0 | 0.0 |
| **Acetylene** [6] | | | |
| 0.02 | 276.5 | 275.0 | 1.5 |
| 0.04 | 259.5 | 262.5 | — 3.0 |
| 0.06 | 247.0 | 254.5 | — 7.5 |
| 0.08 | 238.0 | 247.5 | — 9.5 |
| 0.10 | 230.0 | 240.5 | —10.5 |
| 0.2 | 205.0 | 217.0 | —12.0 |
| 0.4 | 175.0 | 175.5 | — 0.5 |
| 0.6 | 144.0 | 143.5 | 0.5 |
| 0.8 | 105.0 | 102.6 | 2.4 |
| 1.0 | 0.0 | 0.0 | 0.0 |
| **Oxygen** [12] | | | |
| 0.02 | 91.8 | 91.7 | 0.1 |
| 0.04 | 88.0 | 87.7 | 0.3 |
| 0.06 | 85.3 | 85.0 | 0.3 |
| 0.08 | 83.0 | 82.7 | 0.3 |
| 0.10 | 81.2 | 80.4 | 0.8 |
| 0.2 | 74.0 | 72.6 | 1.4 |
| 0.4 | 62.8 | 59.7 | 3.1 |
| 0.6 | 51.5 | 48.0 | 3.5 |
| 0.8 | 38.0 | 34.3 | 3.7 |
| 1.0 | 0.0 | 0.0 | 0.0 |
| **Nitrogen** [12] | | | |
| 0.02 | 87.5 | 87.0 | 0.5 |
| 0.04 | 84.0 | 83.3 | 0.7 |
| 0.06 | 81.7 | 80.8 | 0.9 |
| 0.08 | 79.6 | 78.5 | 1.1 |
| 0.10 | 77.8 | 76.3 | 1.5 |
| 0.2 | 70.4 | 68.8 | 1.6 |
| 0.4 | 59.5 | 56.6 | 2.9 |
| 0.6 | 48.5 | 46.5 | 2.0 |
| 0.8 | 35.0 | 32.5 | 2.5 |
| 1.0 | 0.0 | 0.0 | 0.0 |
| **Chlorine** [14] | | | |
| 0.02 | 121.5 | 121.4 | 0.1 |
| 0.04 | 117.0 | 116.0 | 1.0 |
| 0.06 | 113.0 | 112.5 | 0.5 |
| 0.08 | 110.2 | 109.3 | 0.9 |
| 0.10 | 107.0 | 106.3 | 1.3 |
| 0.2 | 97.0 | 96.0 | 1.0 |
| 0.4 | 81.0 | 78.9 | 2.1 |
| 0.6 | 65.0 | 63.4 | 1.6 |
| 0.8 | 48.0 | 45.3 | 2.7 |
| 1.0 | 0.0 | 0.0 | 0.0 |
| **I-Butane** [17] | | | |
| 0.02 | 172.2 | 172.1 | 1.0 |
| 0.04 | 164.3 | 163.7 | 0.6 |
| 0.06 | 158.5 | 158.5 | 0.0 |
| 0.08 | 153.9 | 154.1 | — 0.2 |
| 0.1 | 150.0 | 150.0 | 0.0 |
| 0.2 | 136.3 | 135.4 | 0.9 |
| 0.4 | 115.5 | 111.3 | 4.2 |
| 0.6 | 95.0 | 89.6 | 5.4 |
| 0.8 | 68.0 | 64.0 | 4.0 |
| 1.0 | 0.0 | 0.0 | 0.0 |
| **n-Hexane** [18] | | | |
| 0.02 | 148.8 | 148.5 | 0.3 |
| 0.04 | 141.7 | 141.9 | — 0.2 |
| 0.06 | 136.6 | 137.5 | — 0.9 |
| 0.08 | 132.5 | 133.7 | — 1.2 |
| 0.1 | 129.0 | 129.8 | — 0.8 |
| 0.2 | 116.0 | 117.3 | — 1.3 |
| 0.4 | 94.6 | 96.5 | — 1.9 |
| 0.6 | 75.8 | 77.6 | — 1.8 |
| 0.8 | 55.0 | 55.5 | — 0.5 |
| 1.0 | 0.0 | 0.0 | 0.0 |
| **Benzene** [13] | | | |
| 0.02 | 169.5 | 169.3 | 0.2 |
| 0.04 | 161.0 | 161.8 | — 0.8 |
| 0.06 | 155.0 | 156.9 | — 1.9 |
| 0.08 | 150.5 | 152.5 | — 2.0 |
| 0.1 | 146.5 | 148.0 | — 1.5 |
| 0.2 | 132.0 | 133.5 | — 1.5 |
| 0.4 | 110.0 | 110.0 | — 0.1 |
| 0.6 | 90.0 | 88.6 | — 1.4 |
| 0.8 | 66.0 | 63.3 | 2.7 |
| 1.0 | 0.0 | 0.0 | 0.0 |
| **Isobutylene** [7] | | | |
| 0.02 | 172.5 | 172.8 | — 0.3 |
| 0.04 | 165.0 | 165.2 | — 0.2 |
| 0.06 | 159.5 | 160.0 | — 0.5 |
| 0.08 | 155.0 | 155.6 | — 0.6 |
| 0.10 | 152.0 | 151.4 | 0.6 |
| 0.2 | 138.0 | 136.8 | 1.2 |
| 0.4 | 113.5 | 112.5 | 1.0 |
| 0.6 | 90.0 | 90.4 | — 0.4 |
| 0.8 | 66.0 | 64.7 | 1.3 |
| 1.0 | 0.0 | 0.0 | 0.0 |
| **Pentane** [8] | | | |
| 0.02 | 157.0 | 157.5 | — 0.5 |
| 0.04 | 150.5 | 150.6 | — 0.1 |
| 0.06 | 145.8 | 146.0 | — 0.2 |
| 0.08 | 142.0 | 142.0 | 0.0 |
| 0.1 | 138.4 | 138.1 | 0.3 |
| 0.2 | 124.0 | 124.5 | — 0.5 |
| 0.4 | 103.0 | 102.4 | 0.6 |
| 0.6 | 85.0 | 82.5 | 2.5 |
| 0.8 | 65.0 | 58.9 | 6.1 |
| 1.0 | 0.0 | 0.0 | 0.0 |
| **Carbon Dioxide** [9] | | | |
| 0.02 | 163.2 | 164.0 | — 0.8 |
| 0.04 | 155.8 | 156.8 | — 1.0 |
| 0.06 | 150.5 | 152.0 | — 1.5 |
| 0.08 | 146.2 | 147.6 | — 1.4 |
| 0.1 | 142.9 | 143.5 | — 0.6 |
| 0.2 | 128.0 | 129.5 | — 1.5 |
| 0.4 | 105.0 | 106.5 | — 1.5 |
| 0.6 | 85.0 | 85.6 | — 0.6 |
| 0.8 | 60.5 | 61.2 | — 0.7 |
| 1.0 | 0.0 | 0.0 | 0.0 |
| **Ammonia** [8] | | | |
| 0.02 | 562.0 | 557.0 | 5.0 |
| 0.04 | 538.0 | 542.0 | — 4.0 |
| 0.06 | 521.0 | 525.0 | — 4.0 |
| 0.08 | 507.0 | 511.0 | — 4.0 |
| 0.1 | 493.0 | 497.0 | — 4.0 |
| 0.2 | 446.5 | 448.0 | — 1.5 |
| 0.4 | 362.0 | 368.5 | — 6.5 |
| 0.6 | 286.5 | 296.5 | —10.5 |
| 0.8 | 200.0 | 212.0 | —12.0 |
| 1.0 | 0.0 | 0.0 | 0.0 |
| **Carbon Monoxide** [9] | | | |
| 0.02 | 94.7 | 94.7 | 0.0 |
| 0.04 | 90.2 | 90.3 | — 0.1 |
| 0.06 | 87.5 | 87.6 | — 0.1 |
| 0.08 | 84.6 | 85.2 | — 0.6 |
| 0.10 | 82.5 | 82.8 | — 0.3 |
| 0.2 | 74.5 | 74.8 | — 0.3 |
| 0.4 | 63.0 | 61.5 | 1.5 |
| 0.6 | 51.0 | 49.4 | 1.6 |
| 0.8 | 36.0 | 35.3 | 0.7 |
| 1.0 | 0.0 | 0.0 | 0.0 |
| **Sulfur Dioxide** [18] | | | |
| 0.02 | 163.7 | 164.0 | — 0.3 |
| 0.04 | 156.0 | 156.8 | — 0.8 |
| 0.06 | 151.0 | 152.0 | — 1.0 |
| 0.08 | 157.0 | 147.6 | — 0.6 |
| 0.1 | 143.0 | 143.5 | — 0.5 |
| 0.2 | 128.0 | 129.5 | — 1.5 |
| 0.4 | 106.0 | 106.5 | — 0.5 |
| 0.6 | 85.0 | 85.6 | — 0.6 |
| 0.8 | 60.0 | 61.2 | — 1.2 |
| 1.0 | 0.0 | 0.0 | 0.0 |
| **Ethylene** [20] | | | |
| 0.02 | 207.0 | 207.4 | — 0.4 |
| 0.04 | 197.3 | 198.3 | — 1.0 |
| 0.06 | 191.0 | 192.0 | — 1.0 |
| 0.08 | 186.0 | 186.7 | — 0.7 |
| 0.1 | 181.5 | 181.8 | — 0.3 |
| 0.2 | 165.3 | 164.0 | 1.3 |
| 0.4 | 137.0 | 135.0 | 2.0 |
| 0.6 | 109.5 | 108.4 | 1.1 |
| 0.8 | 79.0 | 77.5 | 1.5 |
| 1.0 | 0.0 | 0.0 | 0.0 |

there is sufficient uncertainty in the primary data to accept the proposed correlation as it now stands.

## NOMENCLATURE

$\Delta H$ — Heat of vaporization
$\Delta H_{s(Pr)}$ — Heat of vaporization of any compound at a given reduced pressure
$\Delta H_s'$ — Heat of vaporization of compound at normal boiling point
$\Delta H_{w(Pr)}$ — Heat of vaporization of water at a given reduced pressure
$\Delta H_w'$ — Heat of vaporization of water at a reduced pressure corresponding to normal boiling point of given compound
P — pressure
T — absolute temperature
$P_r$ — reduced pressure P/Pc
$P_c$ — critical pressure
$T_r$ — reduced temperature T/Tc
$T_c$ — critical temperature
V — molar volume
R — gas constant
Z — compressibility factor, PV/RT
$Z_c$ — critical compressibility factor, $P_cV_c/RT_c$
m — arbitrary constant

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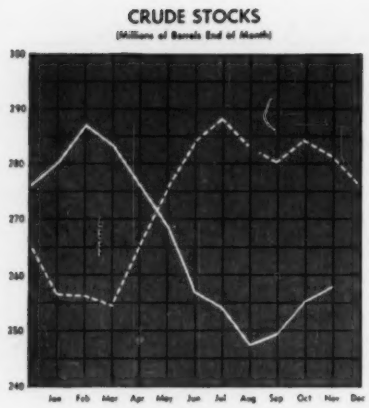


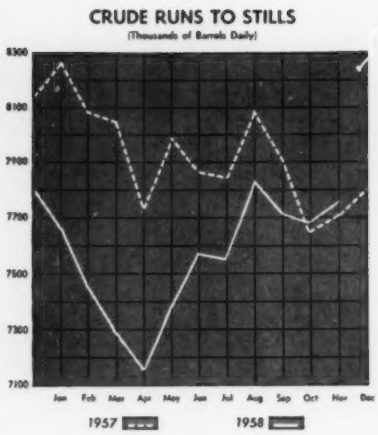


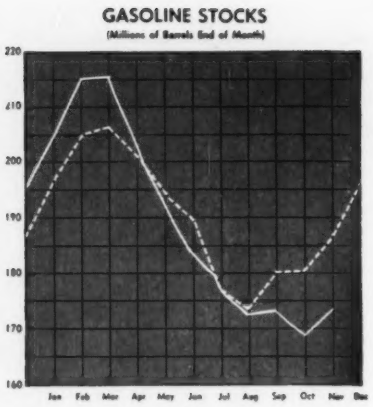


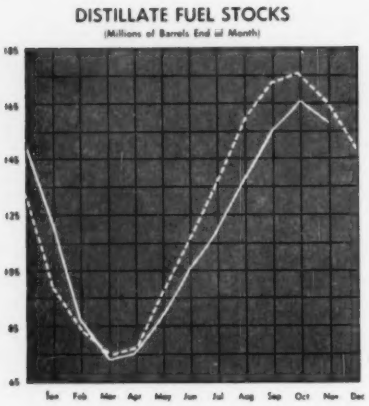


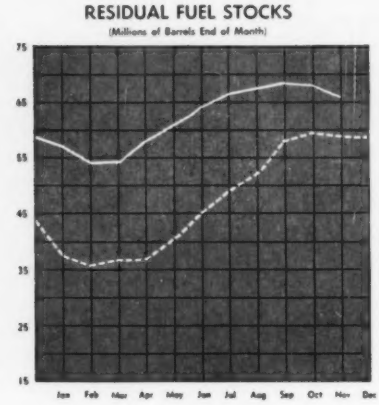


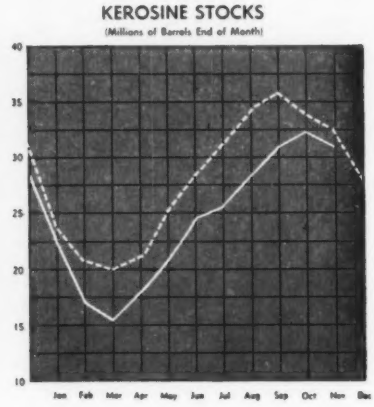


# Taking Stock

- Crude stocks still rising
- Gasoline stocks up again
- All other stocks following seasonal trends

## U. S. Monthly Oil Trends

(THOUSANDS OF BARRELS DAILY)

| | NOVEMBER | | | Oct. | JANUARY-NOVEMBER | | |
|---|---|---|---|---|---|---|---|
| | 1958 | 1957 | % Diff. | 1958 | 1958 | 1957 | % Diff. |
| U.S. Crude Oil Production | 6,990 | 6,824 | +17.1 | 6,910 | 6,664 | 7,197 | — 7.4 |
| U.S. Nat. Gas Liquids Prod. | 810 | 832 | — 2.7 | 800 | 787 | 805 | — 2.2 |
| U.S. Total Imports | 1,809 | 1,488 | +21.6 | 1,720 | 1,657 | 1,528 | + 8.4 |
| East Coast Crude Imports | 806 | 632 | +27.5 | 709 | 762 | 735 | + 3.7 |
| Total Crude Imports | 1,000 | 902 | +10.9 | 906 | 942 | 995 | — 5.3 |
| Total Refined Products | 809 | 586 | +38.1 | 815 | 714 | 533 | +33.9 |
| Total New Supply | 9,609 | 9,144 | + 5.1 | 9,430 | 9,107 | 9,531 | — 4.5 |
| Stock Changes All Oils (Daily) | —117 | —183 | ..... | +452 | —39 | +232 | ..... |
| Total Demand All U.S. Oils | 9,726 | 9,327 | + 4.3 | 8,978 | 9,146 | 9,299 | — 1.7 |
| Gasoline Demand | 3,844 | 3,702 | + 3.8 | 4,017 | 3,959 | 3,943 | + 0.4 |
| Distillate Fuel Demand | 2,098 | 2,080 | + 0.9 | 1,489 | 1,720 | 1,758 | — 2.2 |
| Residual Fuel Demand | 1,493 | 1,573 | — 5.1 | 1,409 | 1,460 | 1,572 | — 7.1 |
| Domestic Demand, All Oils | 9,416 | 8,959 | + 5.1 | 8,678 | 8,863 | 8,713 | + 1.7 |
| Export Demand, All Oils | 310 | 368 | —15.8 | 300 | 282 | 586 | —51.9 |
| Crude Runs U.S. Refineries | 7,768 | 7,692 | + 1.0 | 7,696 | 7,572 | 7,929 | — 4.5 |
| Domestic Crude Runs | 6,785 | 6,658 | + 1.9 | 6,764 | 6,638 | 6,942 | — 4.4 |
| Foreign Crude Runs | 983 | 1,035 | — 5.0 | 932 | 934 | 987 | — 5.4 |

| | TOTAL U.S. STOCKS Millions of Barrels End of Month | | | | STOCKS EAST OF CALIFORNIA Millions of Barrels End of Month | | | |
|---|---|---|---|---|---|---|---|---|
| | November | | | Oct. | November | | | Oct. |
| | 1958 | 1957 | % Diff. | 1958 | 1958 | 1957 | % Diff. | 1958 |
| Crude Oil | 258.1 | 281.8 | — 8.4 | 255.7 | 220.7 | 242.0 | — 8.8 | 222.3 |
| Gasoline | 173.9 | 187.1 | — 7.1 | 168.6 | 150.6 | 159.8 | — 5.8 | 146.2 |
| Distillate Fuel Oil | 159.0 | 166.8 | — 4.7 | 166.3 | 145.4 | 149.8 | — 2.9 | 151.8 |
| Residual Fuel Oil | 65.7 | 59.6 | +10.2 | 68.2 | 32.4 | 28.2 | +14.9 | 33.8 |
| Kerosine | 31.5 | 32.7 | — 3.7 | 32.4 | 31.2 | 32.3 | — 3.4 | 32.0 |

**Source:** Except for latest two months, all data from U.S. Bureau of Mines. Data for last two months from American Petroleum Institute weekly reports and U.S. Bureau of Mines weekly crude stock report; except U.S. Natural Gas Liquids Production and Demand figures which are from WORLD OIL.

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Tetrasodium Pyrophosphate (TSPP)
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**ACIDIZING**
Hydrochloric (Muriatic) Acid
Hydrofluoric Acid
Sodium Bifluoride

**MUD CONDITIONING**
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Disodium Phosphate
Trisodium Phosphate
Tetrasodium Pyrophosphate (TSPP)
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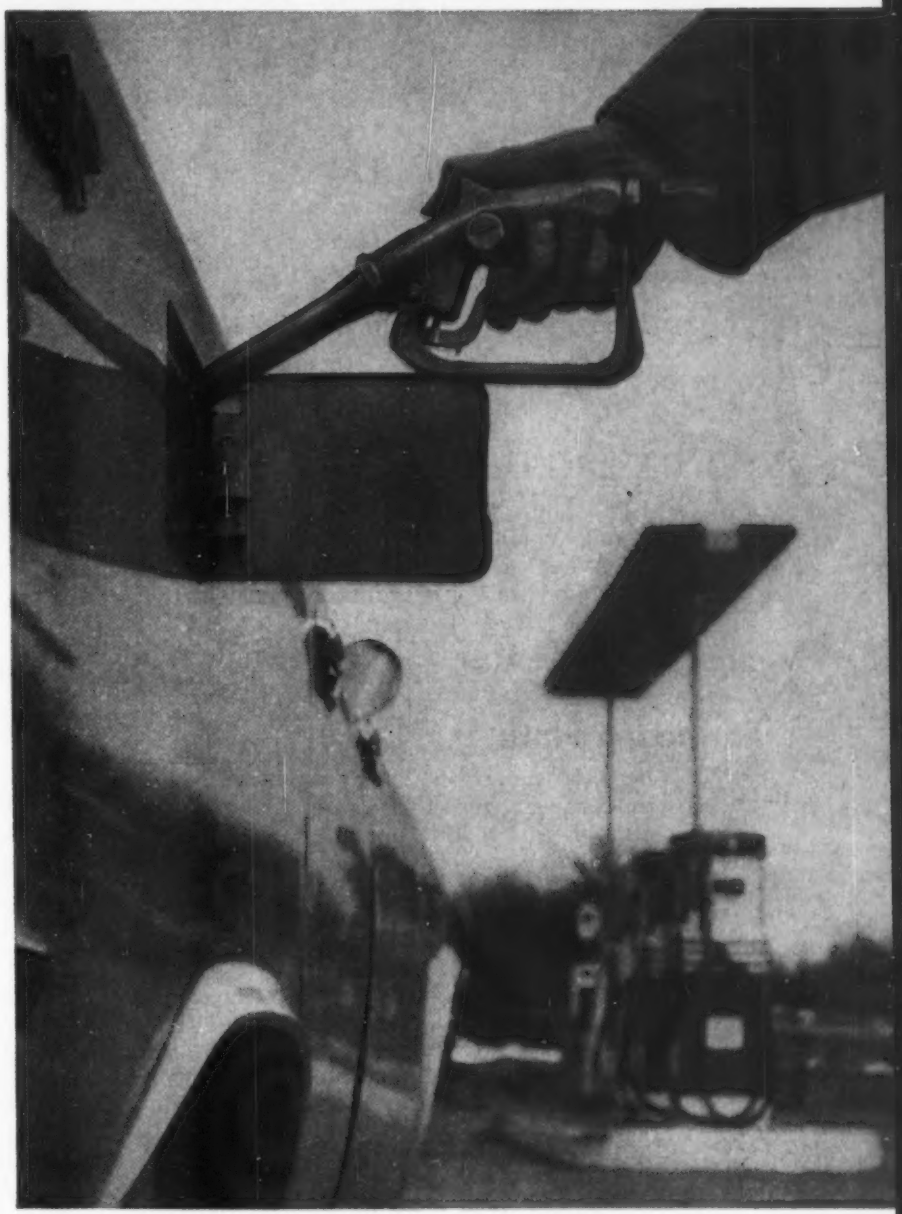

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# Valuable Reading Ahead

***Here's a quick run-down on what's presented in this month's non-technical sections. These departments will keep you right up-to-date with what's new and different in this rapidly changing oil industry.***

## German Rubber Plant

Bunawerke Huls G.m.b.H. has completed its new 49,500-ton per year synthetic rubber plant in West Germany. This month's "Who's Building" lead story will give you a brief but concise rundown on this first German plant that produces rubber based on petroleum raw materials. This is followed by Who's Building's handy "capsule items." To keep informed on construction progress in the Industry . . .

**Keep Going to Page 253**

## What's LPG Doing?

LPG sales increased in 1958—more than 652 million gallons over the 1957 figure. You'll want to read the comprehensive report on this dynamic Industry in "What's Happening in the Industry." There are also dozens of informative stories on the most significant news in the Industry last month. To keep well informed . . . .

**Keep Going to Page 322**

## Formosan Flare

Because the refinery on Formosa must be prepared for nighttime invasion at all times, an ingenious flare stack arrangement has been devised. To learn all the details on this unique operation read this month's "How To Do It." You'll want to employ some of the handy ideas found there in your plant.

**Keep Going to Page 244**

## Men Among Men

Once again AIChE has elected new officers, among which are Dr. Donald L. Katz, president, and Jerry McAfee, vice president. You will learn all about these new leaders of one of the Industry's key organizations in the lead "Men in the Industry" story. Take a look at this informative section to see who's going places.

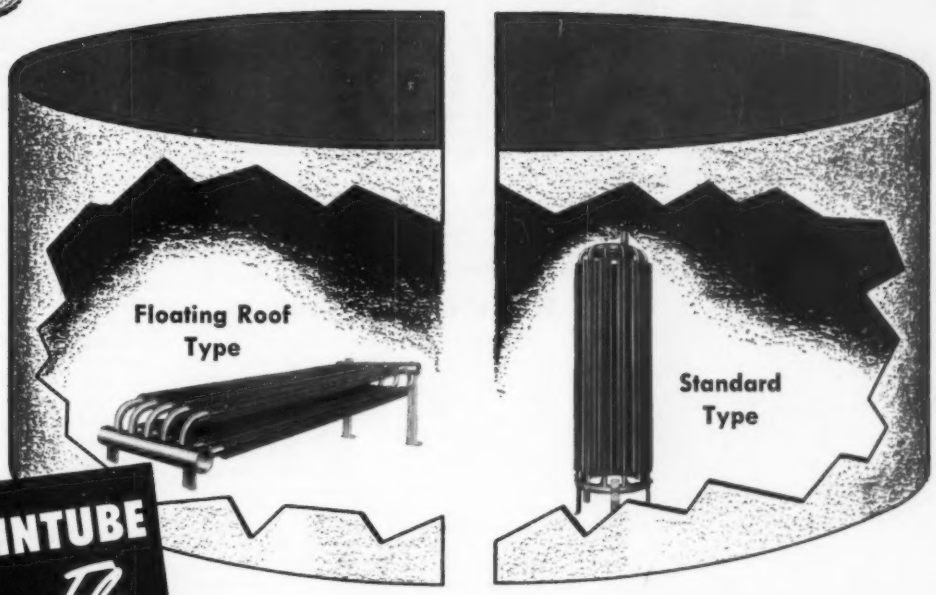
**Keep Going to Page 348**

## Want the Best?

As a man interested in doing what's most economically feasible to keep your plant modern and in top shape, you need to know the latest in equipment developments. The monthly REFINER feature, "What's New in Equipment," will give you a quick rundown on the latest and best implements for your plant.

**Keep Going to Page 382**

# TANK HEATERS, TOO, NEED LEGS TO STAND ON...

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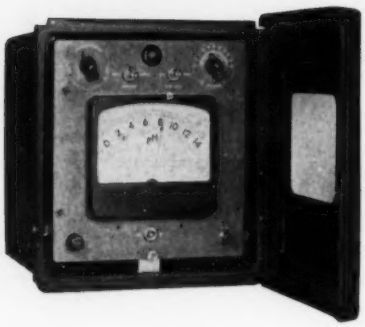

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# NEW BOOKS

## Oil-Shale Patent Index

Oil-shale processes on which patents have been granted by the U. S. from 1946 to 1956 are described in a new Bureau of Mines publication released by the Department of the Interior. The publication is the first of three in a series. Others to follow will list patents issued in the United Kingdom and Europe.

Nearly 300 U. S. patents relating to retorting, refining, and utilizing oil shale and its products are indexed numerically in the new publication, which also contains an alphabetical list of inventors and assignees.

(Klosky, Simon, *Index of Oil-Shale and Shale-Oil Patents: 1946-56, Part I, U. S. Patents, Bulletin, 574,* Superintendent of Documents, Government Printing Office, Washington 25, D. C., $0.60.)

## Far Infrared Applications

"Analytical Applications of Far Infrared Spectral Historical Review, Apparatus and Techniques" reviews the work accomplished to date in the far infrared region, and most of the available literature is cited. A double beam double pass spectrophotometer equipped with cesium bromide optics is discussed, which extends the useful spectral range to 35 microns. Its construction and performance capabilities are reviewed. The book represents an attempt to open a new area of infrared spectroscopy for use in determining molecular structure and solving analytical problems.

(Bentley, F. F., Wolfarth, E. F., Srp, N. E., and Powell, W. R., of Wright Air Development Center, USAF, *Analytical Applications of Far Infrared Spectral Historical Review, Apparatus and Techniques* (PB131514), Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C., 61 pages, $1.75.)

## Pressure Vessel Code Book

"The Unfired Pressure Vessel Code Simplified" is an anlysis of the A.S.M.E. Unfired Pressure Vessel Code, which is made easy to use—thus saving valuable time and material. The 1958 edition contains simplified charts for internal and external pressure, shell thickness, flanged and dished head thickness, flat head thickness, flat cover plate thickness and openings and reinforcements. It also includes new charts on external pressure on heads, stamping, head and shell volumes, welding qualification positions, new information on magnetic particle and penetrating oil tests, plate identification, non identified material, articles on Canadian pressure vessel requirements, the Code symbol and certificate-procedure to follow to obtain them, and welded repair procedure.

(Chuse, Robert, *The Unfired Pressure Vessel Code Simplified,* Robert Chuse, P. O. Box 91, Leonia, N. J., 46 pages, $1.00.)

## Catalysis, Volume VI

"Catalysis, Volume VI," is part of a series giving information on the physical chemistry of catalysis and catalytic processing. This volume deals with the rearranging, cracking, and polymerization of hydrocarbon molecules over catalysts which function in part, at least, by virtue of their acidic nature. The entire context discusses in detail the theory and practice of carrying out catalytic reactions that have become essential parts of the petroleum industry. Specifically, it covers alkylation, isomerization, polymerization, cracking and hydroreforming.

(Emmett, P. H., *Catalysis, Volume VI.* Reinhold Publishing Corp., 430 Park Ave., New York 22, N. Y., 706 pages, $19.50. For sale by Gulf Publishing Co., P. O. Box 2608, Houston 1, Texas, U.S.A.)

## Punched Card Application

"Punched Cards: Their Application to Science and Industry," has been revised and enlarged to surpass its classic predecessor in describing aspects of punched card systems. Those who handle large masses of data will find in this book the principles and methods which apply to small files or the largest. Described is the entire range of cards and equipment available. It discusses both hand- and machine-sorted cards and serves as an elementary instruction manual as well as an advanced handbook.

(Casey, R. S., and Perry, J. W., *Punched Cards: Their Application to Science and Industry,* Reinhold Publishing Corp., 430 Park Ave., New York 22, N. Y., 697 pages, $15.00. For sale by Gulf Publishing Co., P. O. Box 2608, Houston 1, Texas, U.S.A.)

## Petrochemicals Analysis

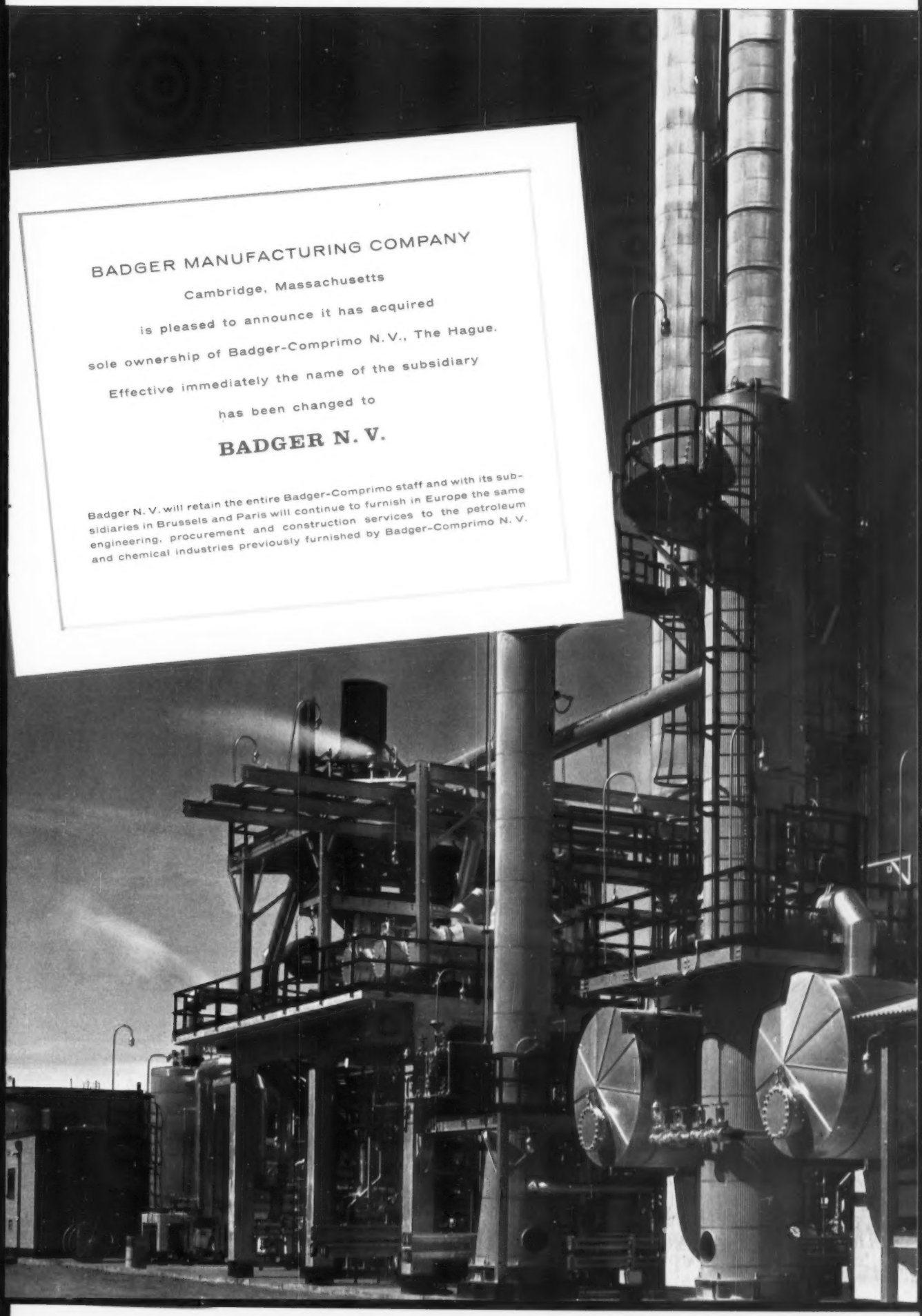
The information set forth in "Methods of Analysis for Petrochemicals" has been assembled from that published by the American Society for Testing Materials, and developed in the laboratories of the Enjay Co., Inc. These methods are presented in an effort to provide the Industry with dependable standard procedures for the analysis of petrochemicals. Many ASTM methods have been applied for quality petrochemical evaluation. In some cases, they can be used without modification. In others, changes were necessary to adapt the methods to special products or to meet customer specifications. Where there were no methods, new ones have to be devised.

(Littmann, E. R., *Methods of Analysis for Petrochemicals,* Chemical Publishing Co., Inc., 212 Fifth Ave., New York, N. Y., 384 pages, $12.00. For sale by Gulf Publishing Co., P. O. Box 2608, Houston 1, Texas, U.S.A.)

## Simulation Studies

"Operations Research for Industrial Management" explains the most recently developed operations research techniques used for executive decision making, with emphasis on the so-called simulation studies. Simulation is used to arrive at decisions on a mathematical or rational basis, rather than by intuitive "rule of thumb" methods. Through simple examples the reader is led into the fundamentals of simulation and of prototype models. The book includes the application of operations research methods to such matters as financial allocation, transportation problems, inventory control, and production setups.

Also introduced are the most recently developed methods in evaluating alternative courses of action and in making major management decisions. This book will be of particular interest to systems engineers, computer technologists, and others interested in applications of research and analy-



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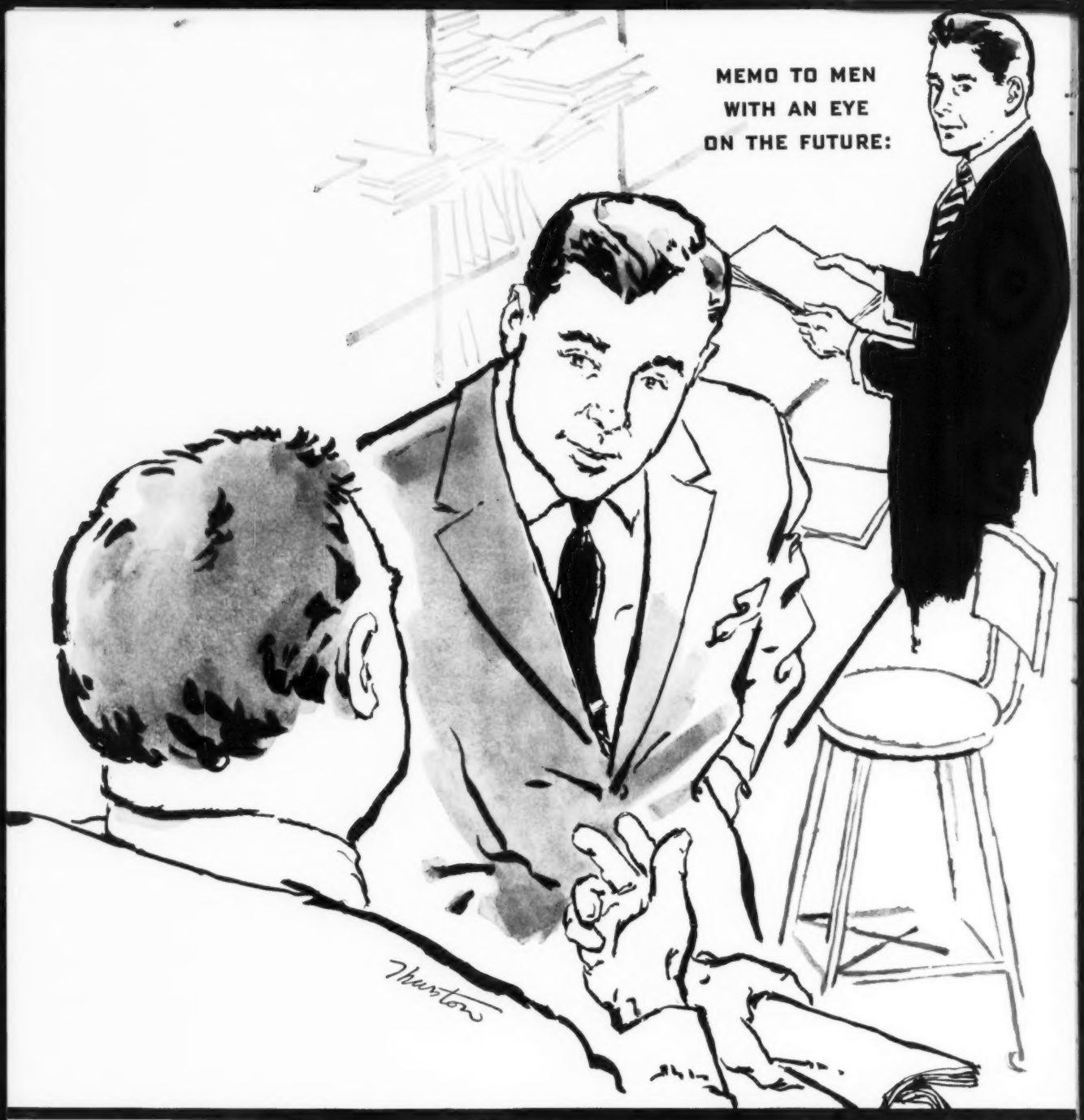


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sis to business and industrial problems.

(Chorafas, Dimitris N., *Operations Research for Industrial Management*, Reinhold Publishing Co., 430 Park Ave., New York 22, N. Y., 303 pages, $8.75. For sale by Gulf Publishing Co., P. O. Box 2608, Houston 1, Texas, U.S.A.)

## Conservation Forecast

"Perspectives on Conservation" is a collection of papers which explore some of the resource conservation problems of the next 50 years from the vantage point of the past 50. They were first presented as lectures at the 1958 Resources for the Future Forum, and were edited for publication by Henry Jarrett of the RFF staff.

Twenty-three authorities prepared material classified as The First 50 Years; Science, Technology, and Natural Resources; Resource Demands and Living Standards; Urban Growth and Natural Resources; Some Determinants of Resource Policy; and Organizing for Conservation and Development.

(*Perspectives on Conservation*, The Johns Hopkins Press, Baltimore 18, Md., 260 pages, $5.00.)

## Phenolic Resin Chemistry

"Phenolic Resin Chemistry" is an authoritative account of the reaction between phenols and aldehydes, covering historical data as well as the more important developments since 1939, when the revolutionary findings on the behavior of phenolic alcohols were first reported. The polymers derived from the interaction of phenols and formaldehyde differ in one important respect from other polycondensation products, in that polyfunctional phenols can commonly form a variety of isomerides of any particular chain length.

The reader will find the book's emphasis to be almost entirely on pure chemical investigations. Technological aspects have been virtually ignored.

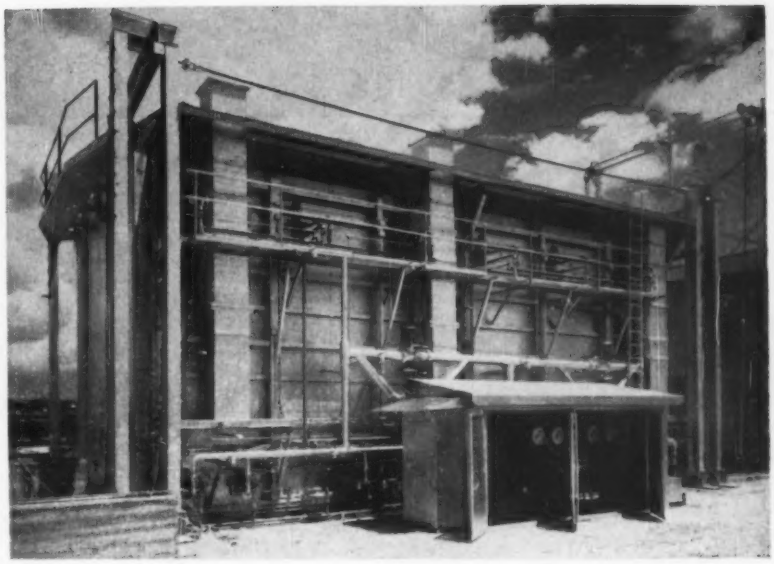
(Megson, N. J. L., *Phenolic Resin Chemistry*, Academic Press, Inc., Publishers, 111 Fifth Ave., New York 3, N. Y., 323 pages, $10.80. For sale by Gulf Publishing Co., P. O. Box 2608, Houston 1, Texas, U.S.A.)

## Scale-up in Practice

"Scale-up in Practice" distills the experience of the chemical industry in translating laboratory achievement into commercial success. It is based on an "Experience in Industry" symposium sponsored by the Philadelphia-Wilmington section of the AIChE and the University of Pennsylvania.

Chapters are included on the factors justifying the operation of pilot plants; a review of scale-up history; simulating operation of processes with computers; hazards involved in scale-up; the process and business economics of scale-up, and organizing for it.

(Fleming, Richard, *Scale-up in Practice*, Reinhold Publishing Co., 430 Park Ave., New York 22, N. Y., 134 pages, $4.50. For sale by Gulf Publishing Co., P. O. Box 2608, Houston 1, Texas, U.S.A.)



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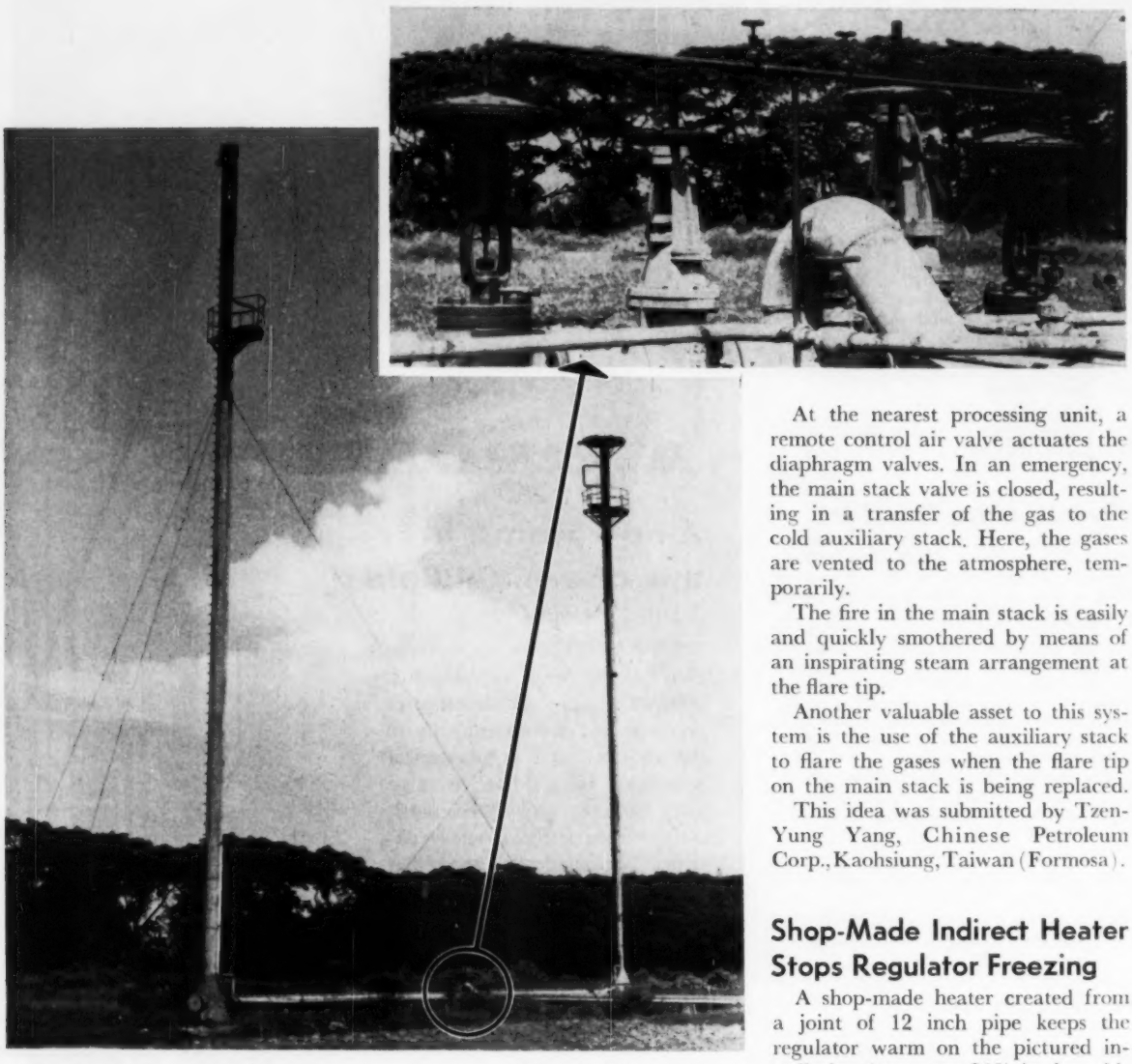
# How To Do It . . .



Gas header diaphragm valves divert flow to auxiliary flare (left) during raid.

## Flare Vents Gases in Air Raid

Because the refinery on Formosa must be prepared for nighttime invasion at all times, a unique flare stack arrangement has been devised.

Twin stacks are located 150 feet apart, as shown in the photo. The left stack is an auxiliary flare used to handle refinery gases when an emergency exists. Diaphragm valves were installed on the main gas header to each stack and connected by means of common air system piping (see insert photo). The auxiliary stack valve is normally closed.

At the nearest processing unit, a remote control air valve actuates the diaphragm valves. In an emergency, the main stack valve is closed, resulting in a transfer of the gas to the cold auxiliary stack. Here, the gases are vented to the atmosphere, temporarily.

The fire in the main stack is easily and quickly smothered by means of an inspirating steam arrangement at the flare tip.

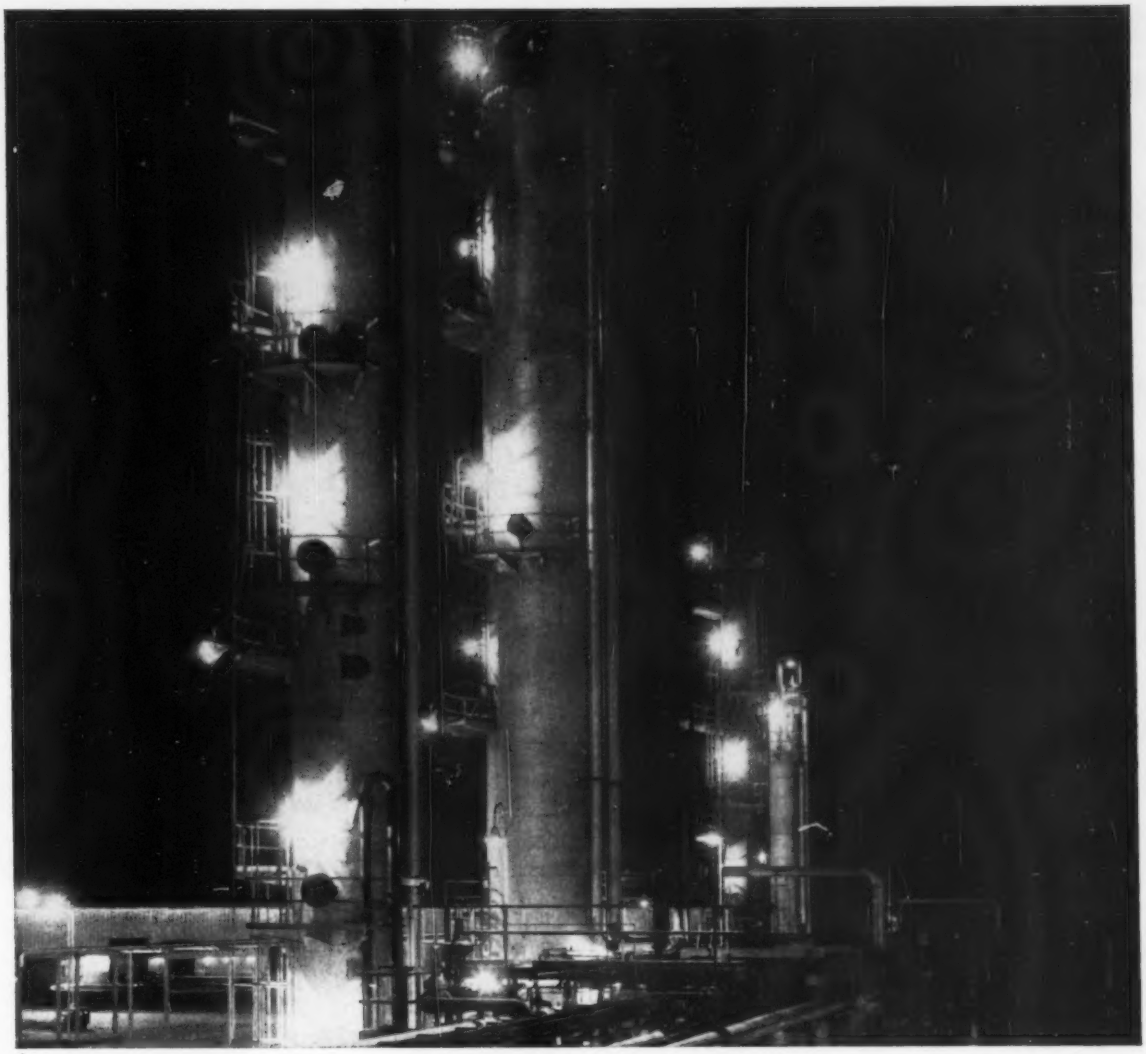
Another valuable asset to this system is the use of the auxiliary stack to flare the gases when the flare tip on the main stack is being replaced.

This idea was submitted by Tzen-Yung Yang, Chinese Petroleum Corp., Kaohsiung, Taiwan (Formosa).

## Shop-Made Indirect Heater Stops Regulator Freezing

A shop-made heater created from a joint of 12 inch pipe keeps the regulator warm on the pictured installation (top, page 246) in the coldest weather. It consists of a joint of 12 inch pipe full of water with a flue and coil of 2-inch pipe to carry the gas. It runs to a point inside the brick meter house so that the interior is kept slightly warmer than the outside. The coil of pipe is on the upstream side of the regulator and the 4-inch flue runs from the outside of the building to a point above the roof.

As shown, the flue is equipped with a jet-type burner supplied with gas from the downstream side of the regulator. A thermostat is placed in the



# More light on producing hydrogen economically ...Tidewater uses heat-resistant Incoloy tubing

The hydrogen plant at Tidewater Oil Company's new Delaware Refinery is the first such unit ever built to supply a refinery's desulfurizer. Capacity is 30 million cubic feet of hydrogen per day.

### High temperature-pressure problem

Metal temperatures in the reformer furnaces are in excess of 1700° F with internal pressures of the reacting gases sufficiently high to emphasize the need for strength and ductility. To provide these properties, the tubes in one furnace are made of extruded Incoloy* nickel-iron-chromium alloy.

### Incoloy is the solution

Incoloy alloy exhibits high creep strength and rupture strength combined with satisfactory ductility. It is not susceptible to embrittlement resulting from structural changes after prolonged heating. Of special importance in containing hydrogen under pressure is the ability of the alloy to provide welds of high integrity. Furthermore, when used in the extruded form, the alloy offers decided economies over other materials.

Incoloy alloy is also used here in the reformer heater outlet manifold and reformer outlet to desuperheater.

For more information, or for help with a high temperature or corrosion engineering problem of your own, write Inco's Development and Research Division.

*Registered trademark

**The International Nickel Company, Inc.**
67 Wall Street New York 5, N. Y.

# INCO NICKEL ALLOYS



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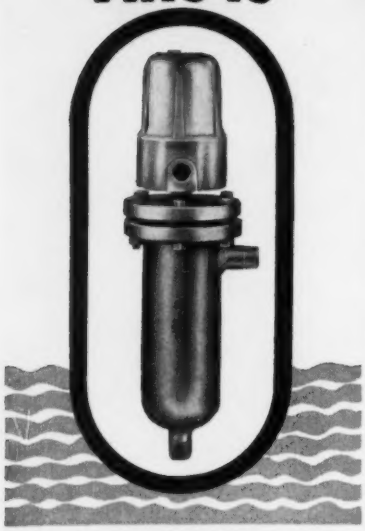

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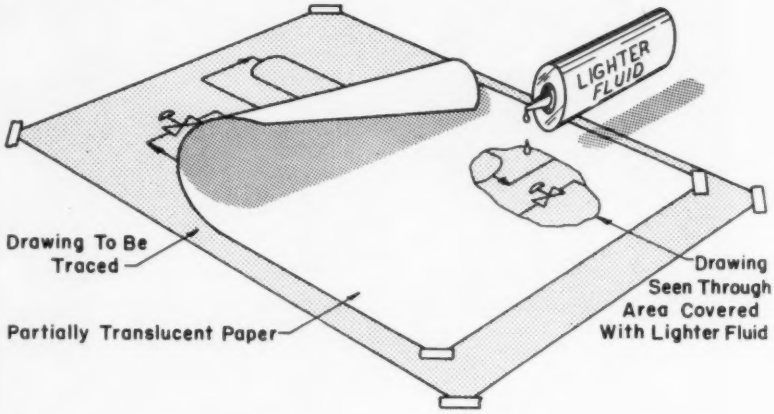
## How to Do It . . .

water bath just above the burner so that a minimum of fuel is used. It is only necessary to keep the water in the pipe around 60 F. to prevent the regulator from freezing.

In order to keep the fire from blowing out, and to protect the burner from the elements, a hinged cover was made by cutting the end of the joint of 12-inch pipe on an angle and welding a cap over the end. It is hinged with a piano-type hinge made of ⅜-inch pipe running along the bottom. This lid is thrown down after the flame is inspected and the heater placed in operation.

This idea was submitted by Harry Hess, Houston.




## Lighter Fluid Makes Paper Transparent

Often it is desired to trace lines from printed or hand drawn sheets onto a piece of paper which is not sufficiently transparent to permit easy performance of the operation. Ordinary white bond paper falls into this category.

One common method is to place both sheets on a back lighted sheet of glass. However, even this is not always successful if the sheet you wish to trace from is opaque. The difficulty may be overcome quite simply by placing the tracing paper directly over the material you wish to trace—then spread some ordinary lighter fuel over the top sheet. The printed matter underneath immediately becomes visible and may be readily traced with either pencil or black India ink. More lighter fuel may be added as required.

The lighter fuel will not smear pencil or black India ink and the

**$$ Your Ideas Are Valuable! $$**

**At least $10.00 will be paid for each idea accepted for "How To Do It." All you need to do is write a brief note telling about your idea, then attach a photo or sketch (if needed), and mail it to Editor, Petroleum Refiner, P. O. Box 2608, Houston.**



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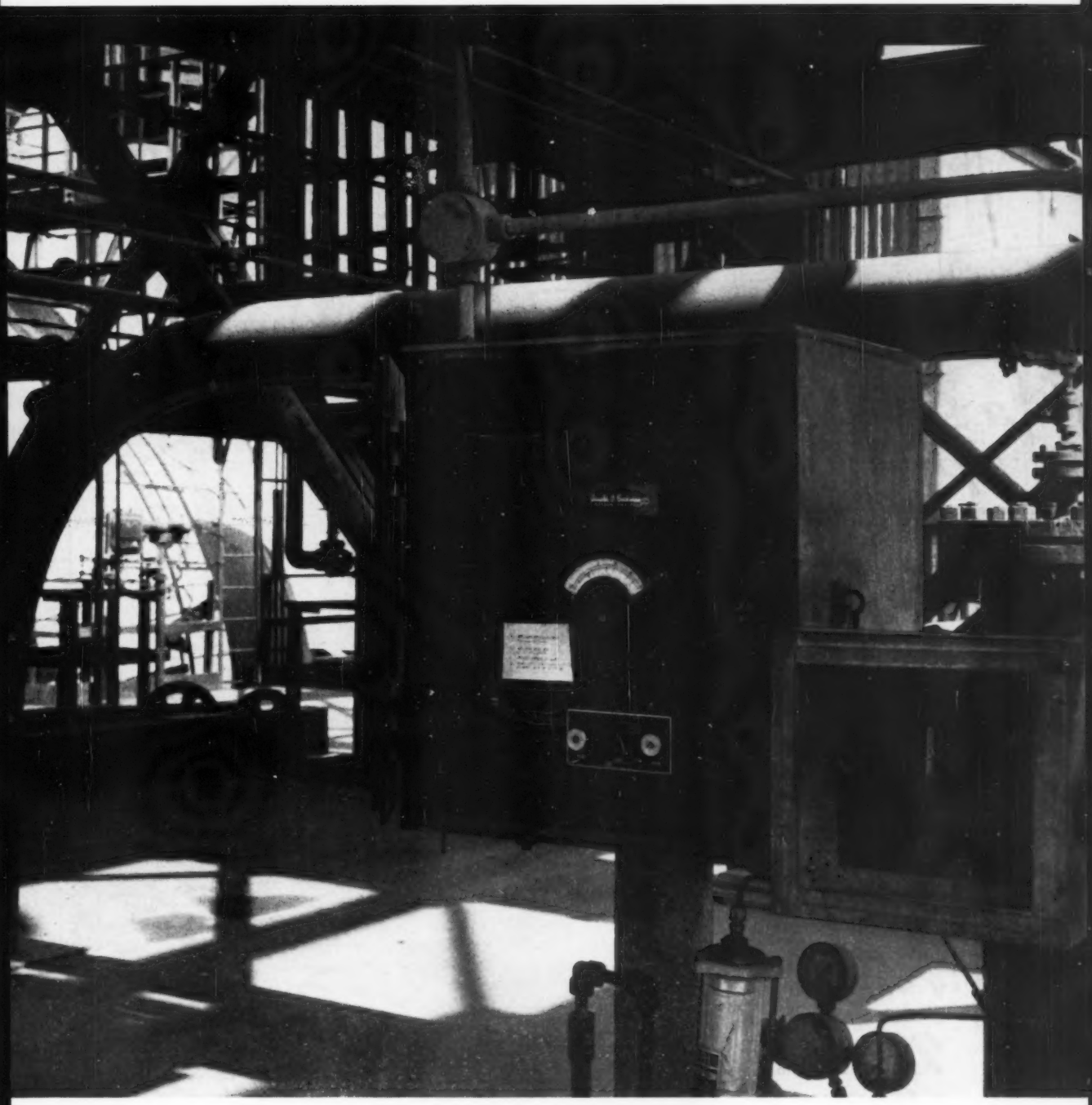

*The sentinel that never gets relief...* Day after day after day, for over 4 years this Beckman oxygen analyzer has maintained vigil on catalyst regeneration. Located eight stories above The Texas Company refinery at Wilmington, California, it has monitored unreacted oxygen, under demanding conditions, with only minimum routine maintenance. Analysis must be continuous, dependable, accurate. ⌘ This Beckman instrument is the only oxygen analyzer to use a direct paramagnetic measurement exclusively, which brings you these advantages: *Dependability*... under the most rugged conditions. *Simplicity*...with no auxiliary measurements to complicate analysis, no extra components requiring extra maintenance. *Accuracy*...with sensitivity and specificity to meet the most critical process requirements. ⌘ Whatever your application, if you want detailed specifications on an oxygen analyzer that withstands tough environments and gives you continuous, dependable answers, write for Data File P-6-25.

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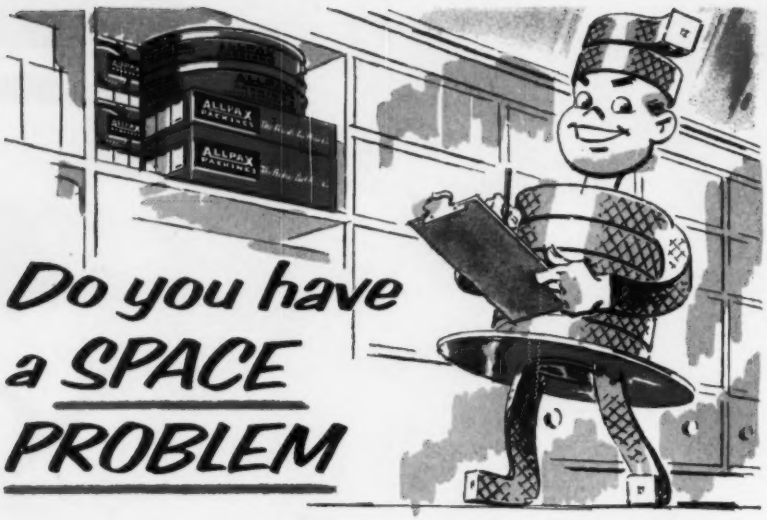


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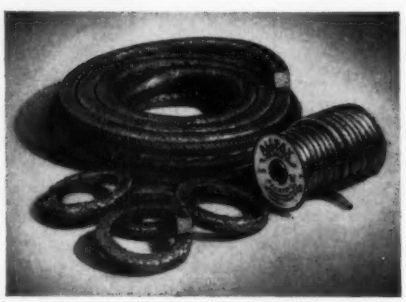

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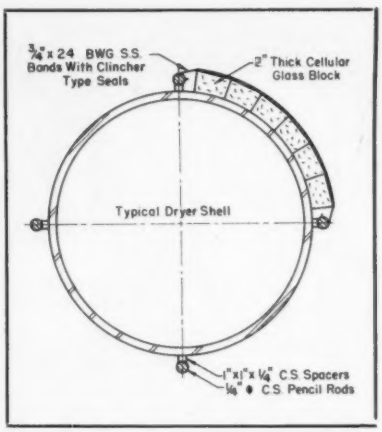
## How to Do It . . .

treated surface readily accepts either pencil or ink. In a few seconds the lighter fuel evaporates without a trace and the paper is restored to normal.

This idea was submitted by J. O. Wright, Calgary, Alberta, Canada.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Typical Dryer Shell
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1/4" ø C.S. Pencil Rods

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This idea was submitted by Max S. Bass, Hyden Newport Chemical Corp., Fords, N. J.


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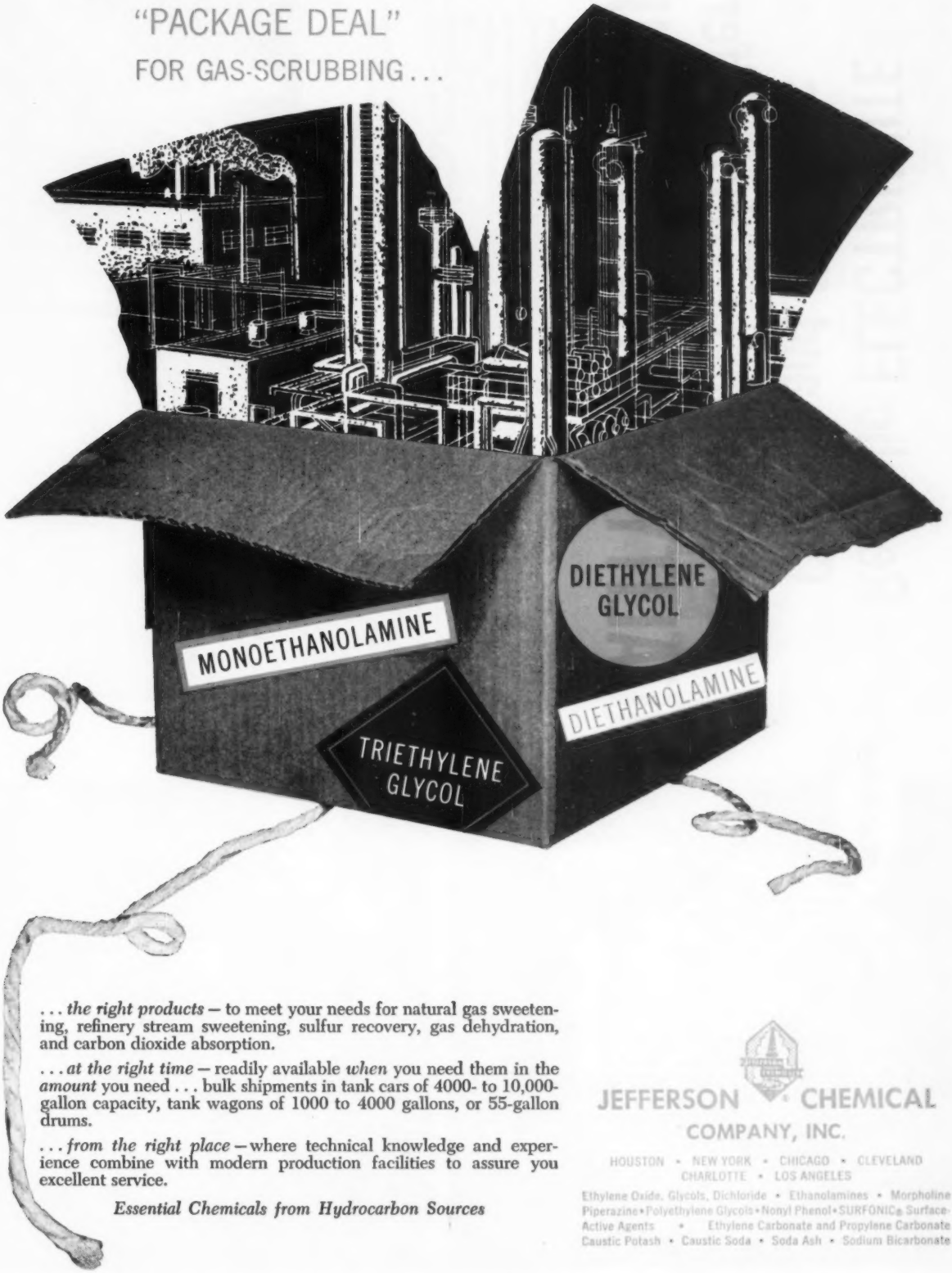


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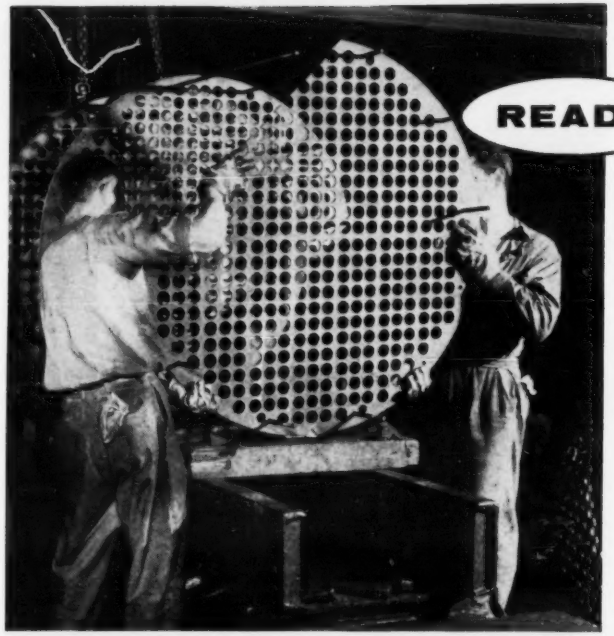

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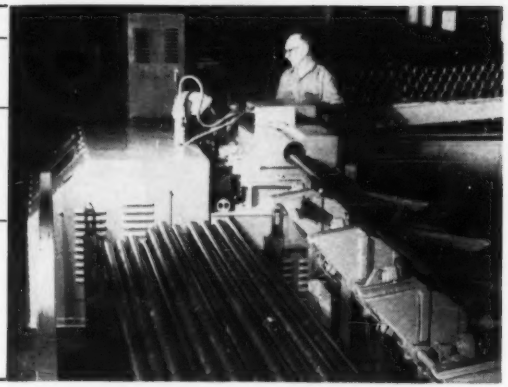
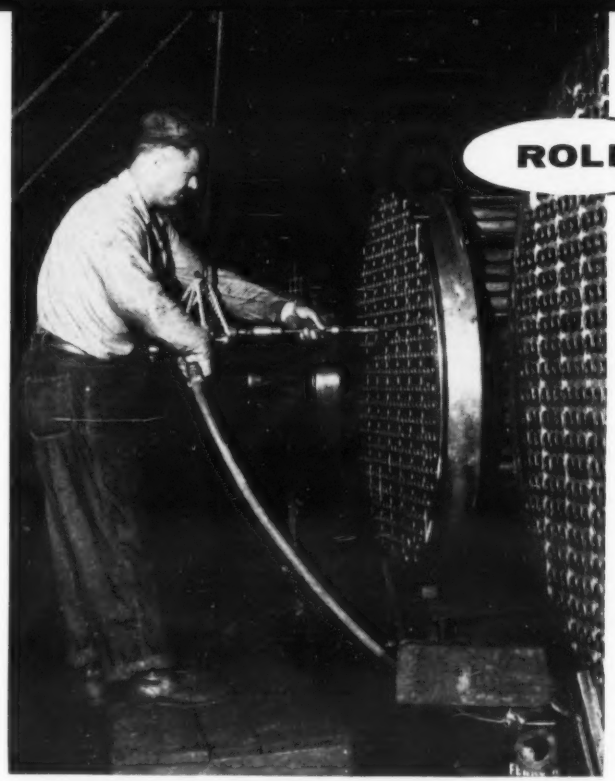
|---|---|---|
| 20 ga. | .006″ | .0025″ |
| 18 ga. | .006″ | .003″ |
| 16 ga. | 12½% of Wall | .003″ |
| 14 and 13 ga. | 12½% of Wall | .004″ |
| 12 ga. and heavier | 12½% of Wall | .005″ |

**FARROWTEST** detects and rejects not only tubing containing defects which completely penetrate the wall; but also tubing with defects equal to, or greater than, those shown in this table. Where required, sensitivity of FARROWTEST equipment can be calibrated to reject defects of lesser specified area than shown in table, at extra cost.



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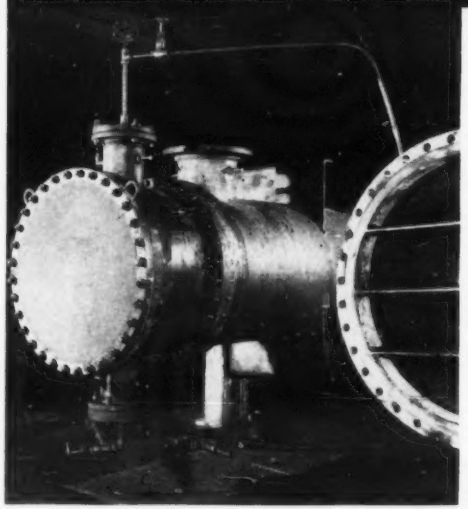

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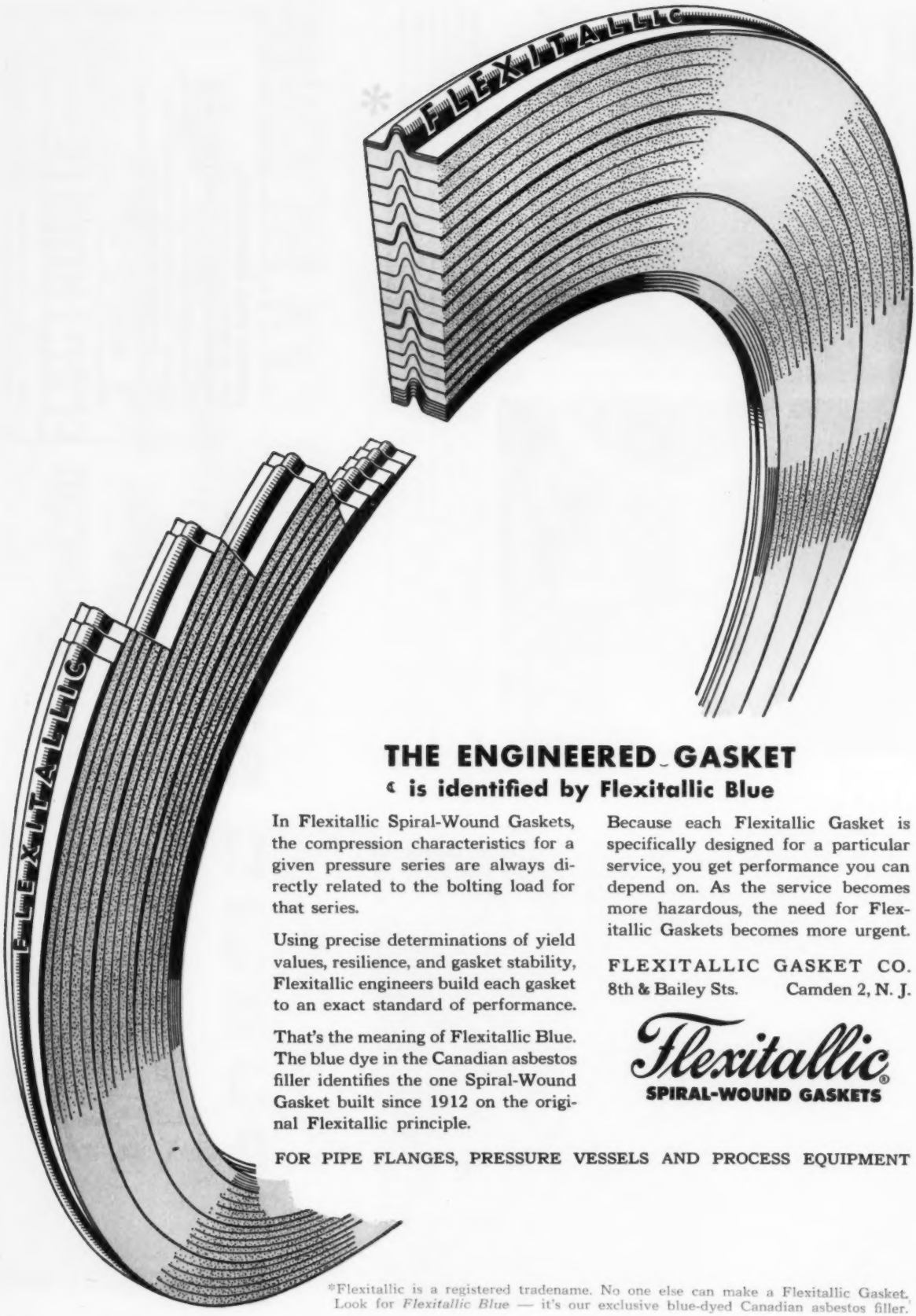


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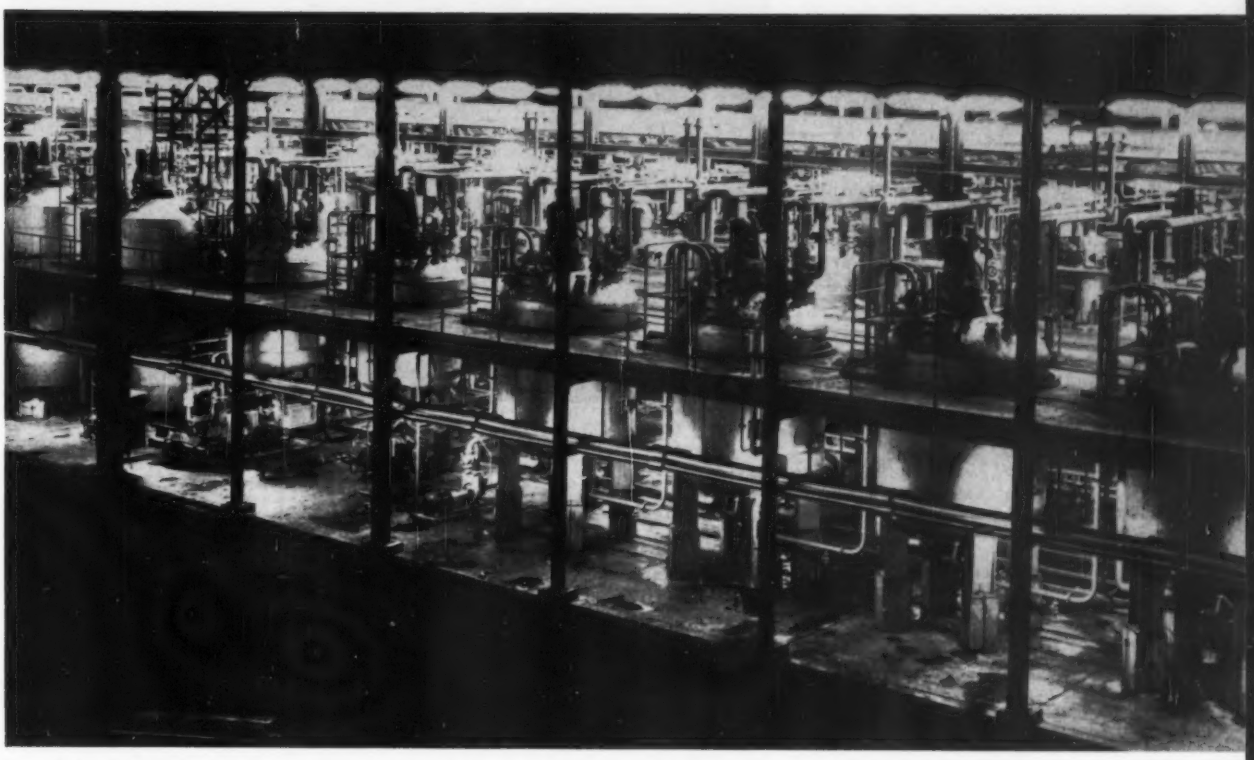
# Who's Building . . .



Notice influence of U.S. construction practice in this open-type building housing semi-continuous polymerization train.

# Petroleum-Derived Rubber for Germany

**The new $42 million Hüls plant is owned by West Germany's four major chemical companies**

The Bunawerke Hüls G.m.b.H. synthetic rubber plant, with an annual capacity of 49,500 tons, was officially commissioned on September 15, 1958. Its design was provided by the parent concerns with the cooperation of Chemische Werke Hüls AG. Invaluable American domestic experience was given the company through the technical assistance of Houdry Process Corp. for butadiene production, and of Esso Research and Engineering Co. for its concentration. The discussion of the design of polymerization and coagulation units with experts of the Firestone Tire & Rubber Co. proved of great value. The design of the plant was carried out by the Engineering department of Chemische Werke Hüls AG.

The sponsors of this undertaking felt that an all-round rubber, to be used both in manufacturing tires and other rubber goods, and to be blended with natural rubber, should be butadiene styrene copolymer.

The $42 million Hüls plant is owned by Western Germany's four major chemical companies. Fifty percent of the share capital of DM 42 is held by Chemische Werke Hüls, and 16.66 percent each by the Bayer, Hochst and the Badische Aniline

groups. Designed for an initial production of 49,500 tons per year, this capacity is soon to be expanded to 77,000 tons, and eventually to 99,000 tons.

**Enjay Co., Inc.** has begun construction of a pilot-plant-type plastics wing, which reportedly will be a miniature plastic-products fabricating plant.

The processing section will have commercial-type production equipment including injection molders, extruders and formers. Some individual machines will have capacities of 150 pounds per hour of finished plastic objects. Other facilities are a mixing and compounding lab, weighing room, chemical-analysis and physical-testing labs.

**Champlin Oil & Refining Co.** is planning a $3 million modernization and expansion program for its Gulf Plains natural gas processing plant, near Bishop, South Texas.

Incorporating a complete modification of present facilities, the program is to provide over-all upgrading of all products, and increase production capacity of light ends such as ethane, butane and propane.

Designed by The Fluor Corp. and Champlin, work on the program is to begin soon, with a completion date set for July, 1959. Fluor will handle engineering and construction.

**The Texas Co.** has completed its 45,000-bpd Puget Sound refinery at Anacortes, Wash. Eight major refining units include fluid catalytic cracking, alkylation, catalytic reforming, catalytic polymerization, and hydrotreating. It has an anti-pollution water treatment plant.

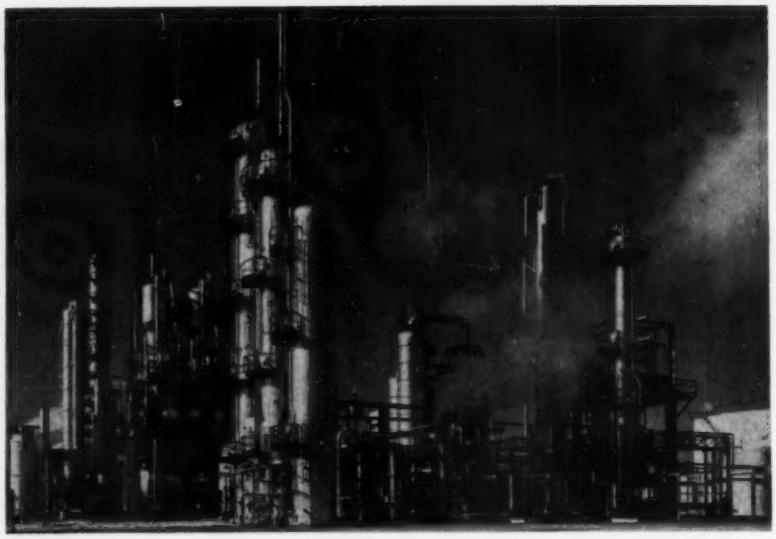
The plant will process jet fuels, regular and premium grade gasolines, bunker oil, two grades of diesel fuel oil, liquefied petroleum gas and heavy industrial fuel oil. It will employ 300, and is located on an 833-acre tract. Ground was broken in February, 1957, and the first unit was placed on stream last September.

**Imperial Oil Co., Ltd.** has awarded construction contracts for a $2.6 million alkylation plant at its Winnepeg refinery to Canadian Bechtel, Ltd. The unit, to produce aviation gasoline, is said to be the second of its kind on the Manitoba prairies, and will replace U.S. imports according to the company. The refinery is already producing jet fuels.

Engineering work for the $2.6 million project has been underway several months, and construction will begin in the spring. When completed around mid-September, the plant will turn out 650 bpd of alkylate.

The project includes facilities for making alkylate and blending it with other components for various grades of gasoline. Handling facilities and tankage will also be built. Part of the installation will be a light ends fractionation unit. It will separate feed for the alkylation unit from gases obtained from the refinery and scrubbing plant at West Gas Fields.

**Columbia Gas Systems** has completed a natural gasoline and petrochemicals plant in Kentucky to extract butane, propane, and other materials from Appalachian gas.



Calcasieu Chemical's new Lake Charles plant uses Shell Development Co. process.

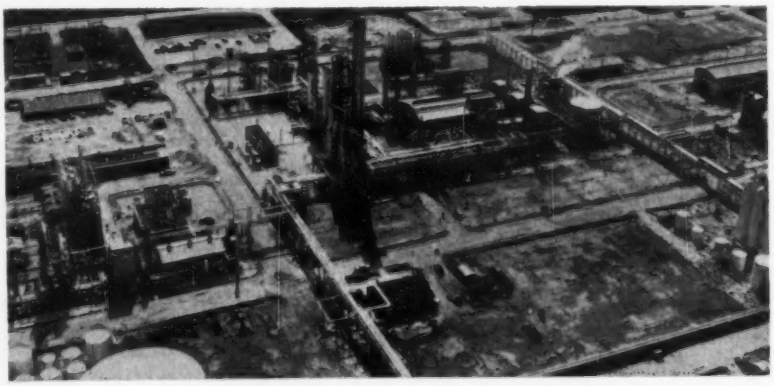
## Calcasieu Adds New Glycol, Oxide Plant

Calcasieu Chemical Corp.'s new ethylene-oxide and oxide-glycol plant at Lake Charles is on stream and producing 8-million gallons a year of ethylene glycol or 60-million pounds per year of ethylene oxide.

Designed and engineered by The Lummus Co., the plant utilizes the Shell Development Co. process. The facility is staffed and operated by Petroleum Chemicals, Inc., which will supply ethylene raw material to the new plant from an adjacent ethylene unit.

The first step in the new unit's process is direct catalytic oxidation of ethylene with oxygen in fixed bed reactors. Here ethylene oxide is produced.

The second step calls for thermal hydration of ethylene oxide to ethylene glycol.



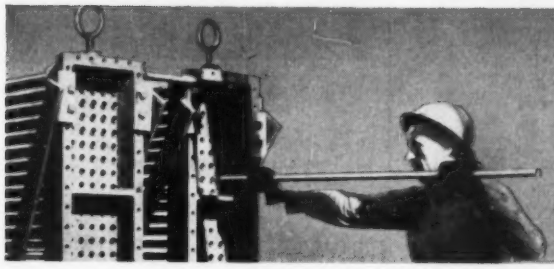
Petroleum Chemical's Lake Charles ethylene plant produces 600,000 pounds per day.

## PCI Up With Lake Charles Ethylene Unit

Petroleum Chemicals, Inc.'s 200-million pound per year ethylene plant at Lake Charles is on stream. It was designed, engineered and constructed by The Lummus Co. to pipeline 99.7 percent ethylene.

Initial ethylene product capacity is 600,000 pounds per day but the plant is designed for rapid expansion to 900,000 pounds per day. Ethylene will be produced in two grades—99.7 assay and 98.0 percent. Co-products will be high assay propylene, a butane-butylene fraction and aromatic distillate. Operations have been marked by continuous production of specification high assay ethylene under widely varying rates and feed stock compositions.

The plant incorporates an ethylene separation process which provides high separation efficiencies, flexibility and reliability. Feed gases are provided from the nearby refineries of Cities Service and Continental Oil Co.'s, by whom P.C.I. is



# CONDENSER AND HEAT EXCHANGER CLINIC

Edited by David S. Hibbard, Metallurgical Engineer
The American Brass Company, Waterbury 20, Conn.

## The trend is to longer, small-diameter heat exchangers in high-pressure, high-temperature systems

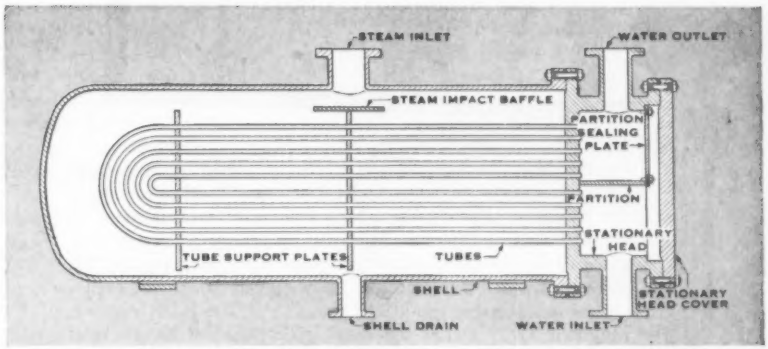
Where relatively high pressures are involved—as in power station feed-water heaters and many exchangers for oil refineries, chemical, and petro-chemical plants—it is very costly to get increased capacity by increasing shell diameters beyond about 48″.

It is more economical to lengthen the equipment. And this means longer tubes—either as straight lengths with a floating head or as U-bend tubes.

**U-bend Tube Design** of exchangers has several inherent advantages, particularly when wide temperature differences exist in the unit. Each U-bend tube individually takes care of its expansion stresses. The number of rolled tube joints is cut in half. The absence of a floating head eliminates one gasketed joint and reduces the total weight of the tube bundle, making handling easier.

The average length of tubes involved is already beginning to crowd the heretofore standard maximum of 60 feet. And The American Brass Company, recognizing the trend to still greater length, has installed new mill equipment to produce tubes up to 100 ft. in straight lengths—in U-bends with the length of the straight leg up to 50 feet. The radius of the bend to the center line can be as small as 1½ times the outside diameter of the tube, or as great as 30 inches.

**Dual-gage Tubes.** For the tubes with short-radius bends in the middle of the bundle, provision should be made for extra metal at the bend to prevent thinning of the tube wall below a safe minimum for the service. Dual-gage tubes are made with extra wall thickness in the area of the bends. This cuts cost and weight, as the extra metal is only at the bends where it is needed and not down the entire length of the tube. Cost savings have been estimated at from a few cents to several dollars a tube, depending on the alloy used. The American Brass Company makes dual-gage tubes one BWG thickness heavier in the bend area.

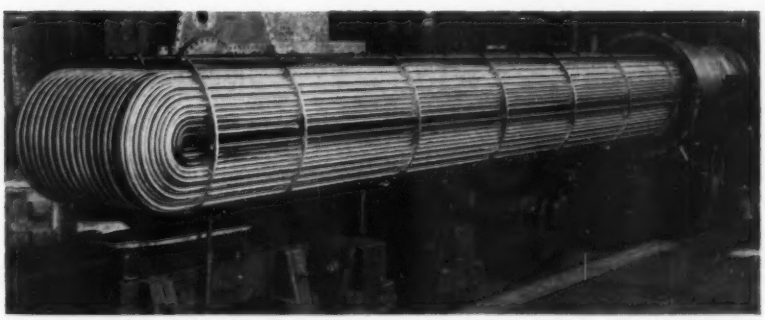



Schematic drawing of U-bend-tube-design feed-water heater. *Courtesy The Griscom-Russell Co.*

**Annealing.** Both single-gage and dual-gage tubes are annealed at the bend to relieve stresses developed in the bending process, which otherwise might lead to stress-corrosion cracking.

**Testing.** Tube quality is particularly critical in high-pressure, high-temperature service. Furthermore, U-bend bundles are so tightly packed that it is difficult to remove a defective tube, particularly at the center. So The American Brass Company has added equipment to make hydrostatic tests up to 6000 psi on even the longest U-bend tubes after they have been bent. Air tests up to 250 psi with tube submerged in water can be made on straight lengths up to 60 feet.

**Technical Assistance.** For more detailed information on extra-long tubes, U-bend, Dual-gage, or Duplex tubes to meet special problems, address: The American Brass Company, Buffalo Division, Buffalo 5, New York. In Canada: Anaconda American Brass Limited, New Toronto, Ont. 5876



Compact tube bundle for a feed-water heater using U-bend tubes averaging 45′ long. Similar units have been made with tubes up to 85′ long.

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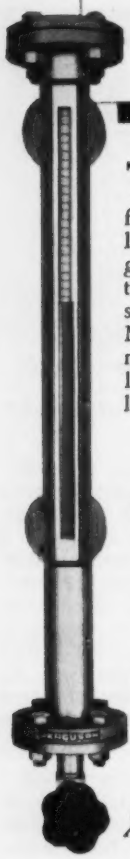

THE New Jerguson Magnetic Gage marks an important advancement in the technology of liquid level observation, for it makes possible the safe and accurate measurement of liquid levels in the many installations where other types of gages cannot be used. Wherever gages with glass, gaskets and threads cannot be tolerated . . . wherever dangerous explosive or inflammable conditions prevail . . . the New Jerguson Magnetic Gage makes the ideal, safe gage for liquid level measurement. The gaging mechanism, incorporated in a stainless steel chamber, actuates the scale which shows the liquid level in bright red contrasted with silver above.

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## Who's Building . . .

jointly owned—and from P.C.I.'s new ammonia plant.

Part of the new plant's output feeds the adjacent Calcasieu Chemical Corp.'s new ethylene oxide and glycol plant. (See story top of page 254.)

All major compressors in the low temperature fractionation unit are driven by three 12,500 hp gas turbines. Gas turbine exhaust serves as preheated air for three high pressure steam generators. High efficiency expanders provide low temperatures for maximum ethylene recovery.

**Pan American Petroleum Corp.** has started up its new gasoline plant 18 miles north of Monahans, Texas, the eighth such unit built in West Texas by Pan American.

The Monahans plant is processing casinghead gas produced with oil from the North Monahans field. Initial capacity of the new facility is 4-MMcf of gas a day. It is equipped with one main gas compressor and a refrigeration compressor. By means of compression and refrigeration, liquid petroleum hydrocarbons are extracted from the casinghead gas produced with oil from field wells.

The liquid products are stabilized by removing methane and ethane, and the stabilized product is sold to Phillips Petroleum Co. and moved by pipe line to their processing facilities.

The residue or dry gas left after processing is being sold to Pioneer Natural Gas Co., Amarillo. Plant design allows eventual addition of two more compressors and related equipment to increase capacity to 12-MMcf of gas a day.

Plant design also allows eventual injection of the dry gas back into producing formations for secondary recovery purposes, if gas injection proves practical. However, no definite plans have been made regarding secondary recovery at North Monahans, according to Pan Am. Monahons plant construction started in July and was completed November 9.

**Sun Oil Co.** has begun construction of a large natural gas processing plant in the Laverne Field of Harper County, western Oklahoma. Sun will be the operator for itself and 11 other companies. The plant will produce propane, normal butane, isobutane, and natural gasoline.

The J. F. Pritchard Co. will handle construction, which will cost about $3.5 million. Completion is slated for July, 1959.

The plant, to occupy a 40-acre site, will be just west of Laverne, Okla. It will process 100 MMcf of gas per day and may expand to 150 MMcf later. It reportedly will be the first of its type in the U.S. to

## ERRATA

**In the article "Heat Transfer Nomographs," November, page 279, the example showing use of Figure 4 gives an answer of 3,000 lb./hr. sq. ft. This is a typographical error. Actually, the answer should be 30,000 lb./hr. sq. ft.**

**On page 200 of the December issue it was reported that R. C. Adam, Magnolia Petroleum Co., was to move from Dallas to Beaumont. Actually, Adam is moving from Beaumont to Dallas. Our apologies.**



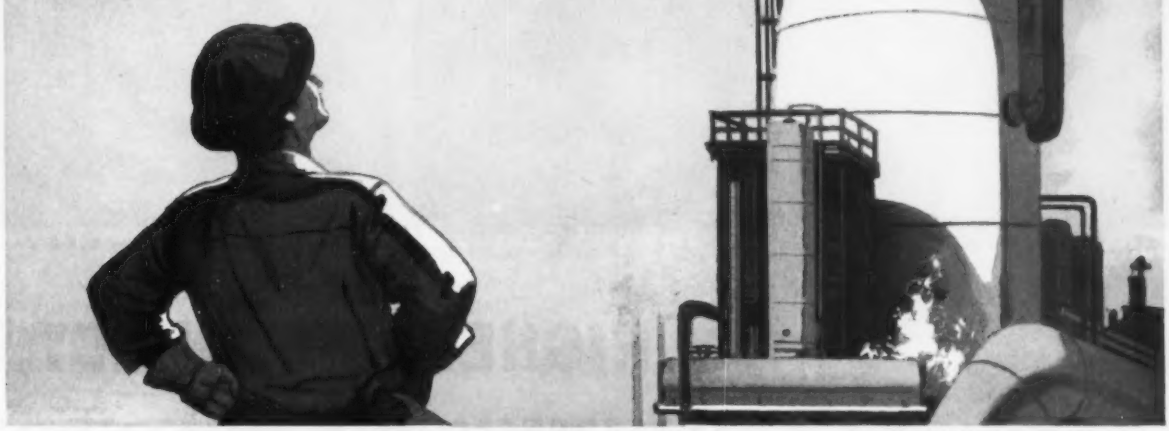
Ultraformer heater for American Oil Co. at El Dorado, Arkansas.

# AIRETOOL...

## pioneers in the development of pneumatic tools for tube maintenance

Continuous research and development by Airetool has produced many new and remarkably efficient tube maintenance tools for the oil industry. Now, as in the past, Airetool leads the way in putting air to work cutting costs in refinery operation.

For more than 28 years, Airetool has pioneered new developments in pneumatic equipment which have become standard in the oil industry. Airetool was first with non-tracking, variable pitch New Form Cutters . . . barrel-type and double expansion cleaner heads . . . first in automatically-controlled tube rolling equipment . . . first in retractive rolling of thick tube sheets. Catalyst cleaners for Poly units are another Airetool development. For the oil industry, Airetool perfected powerful pneumatic motors of slip-fit construction designed for non-stalling operation.



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You can't match the efficiency of Airetool tube maintenance tools. This is particularly important today when economical maintenance of tubular equipment is so vital in reducing overall costs. In the oil industry's second century of progress, as in the first, it will pay you to consult your Airetool representative. Catalogs available upon request.

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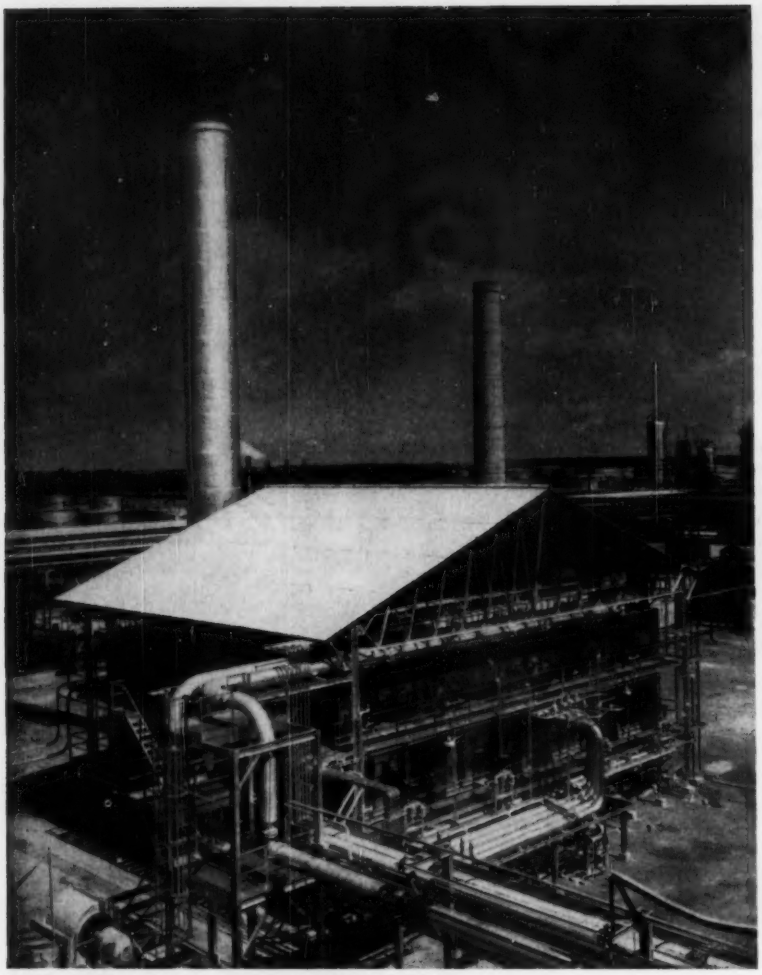
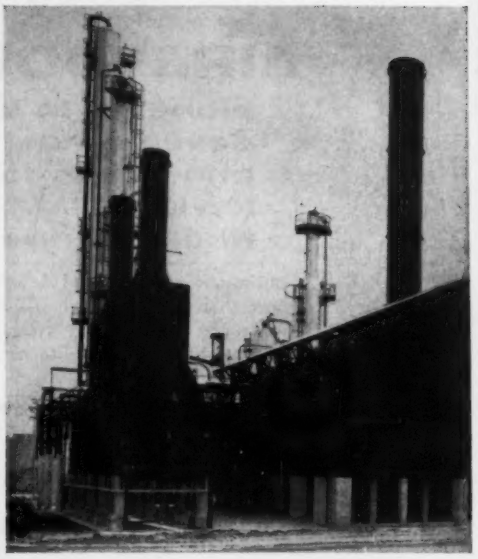
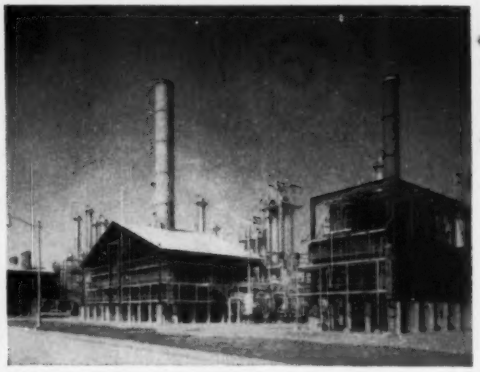


Portable crude heater for Magnolia Petroleum Company, Beaumont, Texas.

Ultraformer heater for American Oil Co. at El Dorado, Arkansas.





Platformer and desulphurizer heaters for Shell Oil Co. at Deer Park, Houston, Texas.

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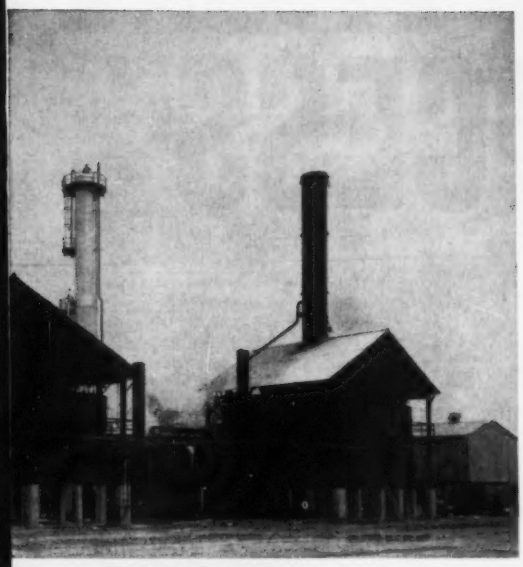
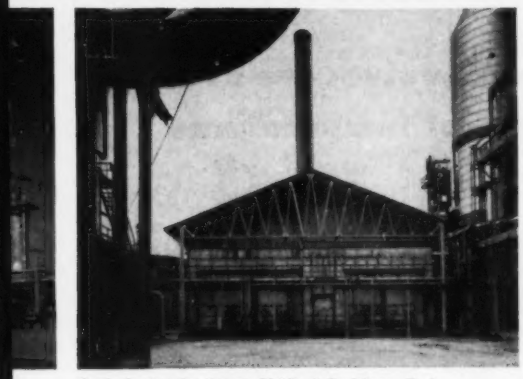
Major refiners maintain large engineering and economics staffs who can evaluate the performance of important heating equipment. They buy more Lummus oil heaters because they *know* through statistical comparison that Lummus gives them *more heater per dollar*.

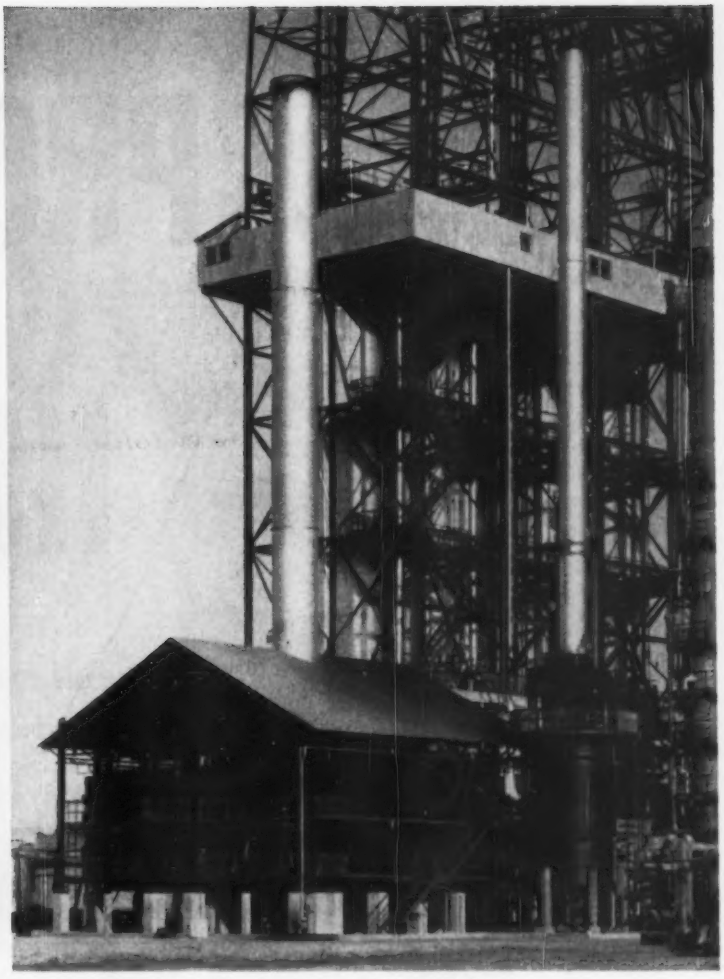
Lummus offers over a quarter of a century of oil heater experience for petroleum refineries, chemical and petrochemical plants. The highly trained engineering staff of the Oil Heater Division is ready in the Lummus New York office to give each job the full benefit of its accumulated know-how in this field.

Lummus oil heaters, of both special and standard design, range from 100,000 to 300,000,000 Btu per hour. As illustrated above, neither size, type nor location of the unit presents a problem to Lummus. Because Lummus offers *every* type of oil heater, you can be sure that we will recommend the *right*





Crude heater for Socony Mobil at Paulsboro, N. J.



Delayed coker heater for the American Oil Co. at Yorktown, Virginia.

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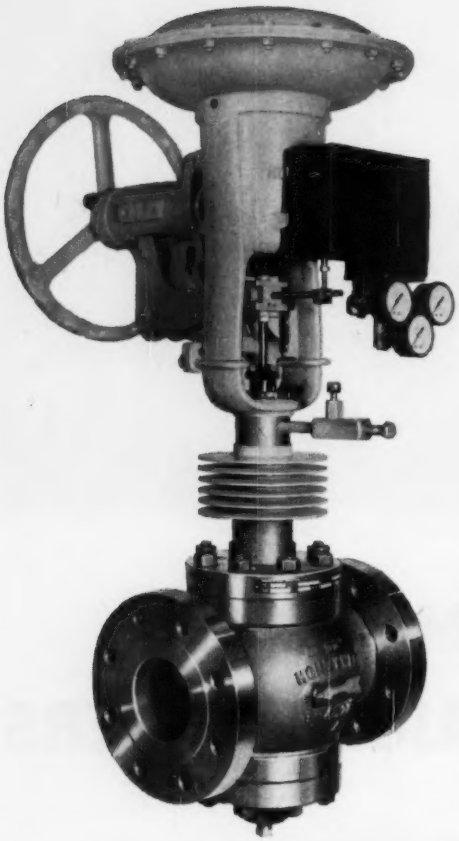

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Whether you're talking about 1200 or minus 450° F, there's a Honeywell automatic control valve for your process flow. The Honeywell valve illustrated—Series 800, Type 11 double seated—is designed to handle fluids at 1200° F. This application requires such features as: welded-in, solid stellite guide bushings . . . stellited guide posts . . . seal-welded seat rings . . . spiral wound, asbestos-filled, stainless steel gaskets . . . high-temperature bolting . . . extended bonnet with fins . . . designed clearances for non-sticking, non-galling operation.

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## Who's Building . . .

use gas-fired turbines for generating power and process heat.

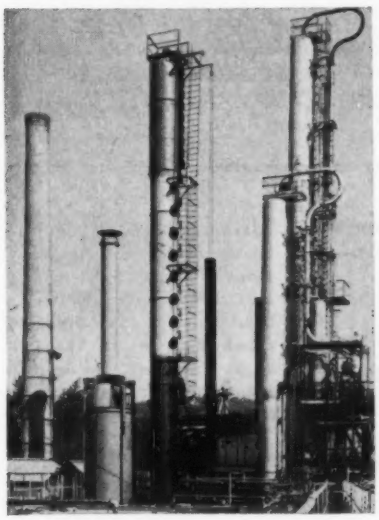
Sun's Southwest Production division Gas department will supervise construction and operate the plant for the Mid-Continent Production division. Michigan-Wisconsin Pipe Line Co. has begun construction of a gas gathering system for the Laverne Field, plus a 56-mile main line to take the Oklahoma gas into its Milwaukee-Detroit trunk line.

**Continental Carbon Co. and Phillips Petroleum Co.** are forming an equally owned French Company to build and operate a carbon black plant. It will have an initial capacity of 56 million pounds annually of the oil black types now used generally by the rubber industry. The engineering and design work is nearing completion, although the location of the plant has not yet been finally decided. Phillips Petroleum's process will be used.

**HEF, Inc.** plans to produce four million pounds per year of ammonium perchlorate in its new plant being built near Columbus, Miss. With construction well underway and most of the equipment already delivered, the company estimates that plant tune-up should begin this month, with full-scale production expected in February.

HEF, Inc. is jointly owned by Hooker Chemical Corp. and Foote Mineral Co. The plant is being constructed on property adjacent to Hooker's sodium chlorate manufacturing plant, thus providing a ready source of raw material for both ammonium and lithium perchlorate.

**Standard Oil Co. (N. J.)** is building a refinery in Slagen, Norway, on the west side of the Oslo Fjord, 50 miles from the Norwegian capitol. The refinery, reportedly the first complete one ever built in Norway, will occupy a 600-acre site and will be complete in mid-1960.



A new distillation unit is nearing completion at the L. Sonneborn Sons, Inc., Franklin, Pa., refinery. Several weeks ago, the unit's 80-foot tower was erected by an outside contractor. Since then, the refinery's own construction crew has been handling pipe-fitting, insulation, and steel-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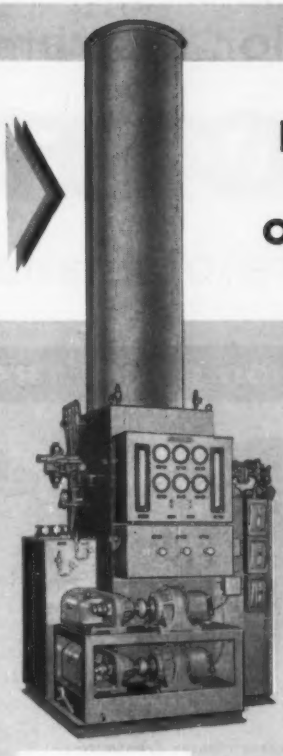

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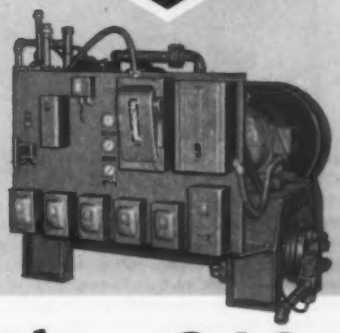

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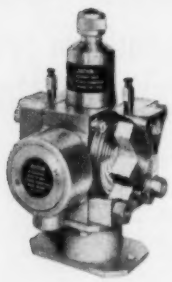
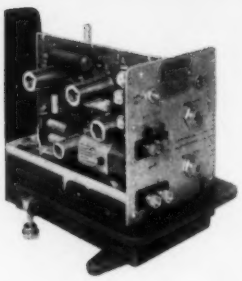
with all the outstanding features of

## INSTANTANEOUS SENSING AND TRANSMITTING UNITS

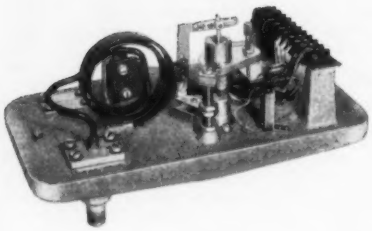


**707T DP Transmitter.** It provides direct conversion from differential pressure to an AC signal. No maintenance . . . insensitive to vibration . . . self-draining and venting . . . positive over-range protection to 1500 psi . . . no process fluid in contact with internal parts, double stainless diaphragm seal between process and electrical components . . . no stuffing box, no bending members, no pivots, no flexible diaphragms nor torque tube seals. No vacuum tubes, no transistors—only a simple differential transformer. Highly linear adjustable silicone damping. Perfect for all flow applications. External zero, with wide range of zero suppression. Designed for use in Class I, Group D, Division I areas.



**700T Potentiometer Transmitter.** Unsurpassed for sensing and transmitting Temperatures (either thermocouple or resistance elements), Load, Speed, pH, or other millivolt signals. Electronic balancing eliminates the need for slide wires, batteries, standard cells or moving parts. Continuous vernier adjustment of span or zero is simplest on the market.

Interchangeable plug-in service "cans" permit quick adaptation of one instrument for use with different primary elements. Amplifier plugs in for simple servicing. Infinite sensitivity to the input signal. Weatherproof case permits field mounting. Users consider it the finest potentiometer transmitter available.



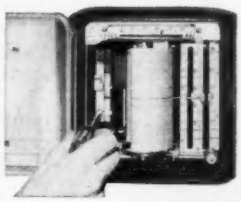
**705T Pressure Transmitter.** Bourdon tube senses pressure changes and moves the core of a differential transformer to change its electrical output. A simple, extremely dependable unit, built for many years of trouble-free service. Simple span and zero adjustments. Pressure ranges from absolute to 2000 psi.

• • •

*See your Taylor Field Engineer for full details or write for Bulletin. Taylor Instrument Companies, Rochester, N. Y., and Toronto, Ontario.*

## VALVE POSITIONER

A true electro-pneumatic valve positioner, permits full utilization of the superior performance of electronic control, coupled with the power and smooth throttling action of pneumatic diaphragm motors. Pneumatic high-capacity, leakless booster relay is easily accessible for maintenance without exposing the electrical system. Unmatched stability due to powerful balanced armature reduces susceptibility to shock and vibration to a minimum. Designed for Class I, Group D, Division I areas.



**1. Front Adjustments** and all the features of the famous 90J Transcope Pneumatic Recorder. With chart, pen and set-point side-by-side (as in Transcope Pneumatic Recording Controllers) all pertinent process information is immediately visualized. Hence operators make fewer mistakes. All available in one 6" x 6" cutout.

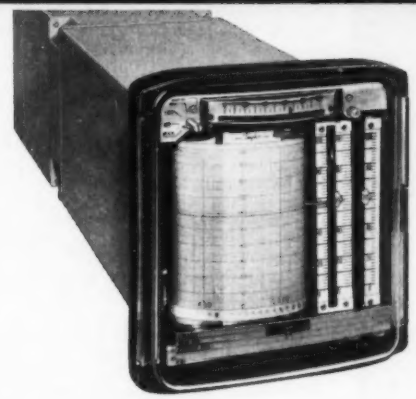
*Taylor Instruments*

sets new standards in

# INSTRUMENTS

## the highly successful TRANSCOPE* line!

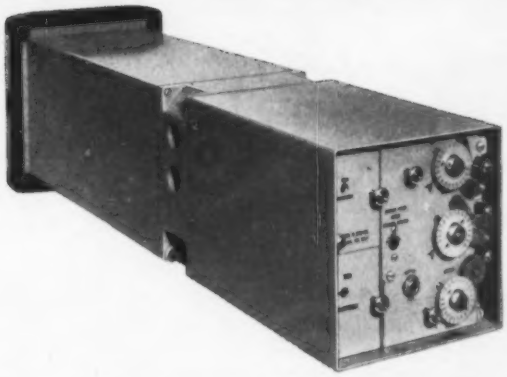
### AC or DC RECORDER



Parallels electronically all the features of the TRANSCOPE Pneumatic Recorder that have won such wide acclaim. Positive, precise pen positioning provided by actual servo-motor, hundreds of times more powerful than meter type movement. Control settings and adjustments can be made from front or rear of case. Recorder can be removed without disturbing process control. Bumpless manual-to-automatic transfer is obtained without manual matching of set point and process. Plug-in Set Point Transmitter permits uninterrupted control.

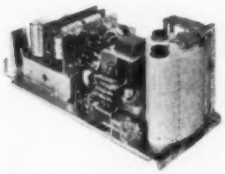
All transistorized (solid state), the 701J Recorder is unaffected by ±10% line voltage variation; thus there is no need for an expensive constant voltage source. All principal assemblies and sub-assemblies are plug-in type for flexibility and easy accessibility.

### AC or DC CONTROLLER

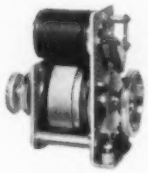


Embodies all the advantages of the most advanced control circuits. The unique diode limiter circuit permits even the two-response controllers to eliminate overpeaking on most applications. It is effective *at all times,* whether the variable is approaching control point from above or below; on changes in set point; following major process disturbances; or on start-up.

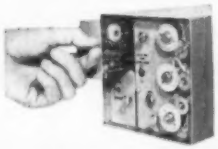
Interchangeable, plug-in assemblies permit conversion to either fast or standard reset and two-response or three-response controllers. Unparalleled rangeability makes this a universal controller. Unaffected by line voltage changes up to ±10%. Controller signal gives multiple valve operation. Output signal from 1-5 Ma feeds into any load from 0-10,000 Ohms. Plug-in assemblies: control responses, operational amplifier, AC/DC Converter, DC reference supply and controller.



**2. Interchangeable Recorder Slide.** Completely transistorized. Unaffected by a supply voltage change up to ±10%.



**3. Powerful Servo Motor** gives more precise pen positioning than ever before. More accurate records.



**4. Plug-in Controller Sub-Assemblies.** Printed circuit boards, mercury bottle disconnect switch.

**5. Extremely Stable Controller Amplifier,** utilizing latest design techniques and premium components.

*Reg. U.S. Pat. Off.

## MEAN ACCURACY FIRST



For more data on advertised products, use Readers' Service Cards, last page.

# REWARD

Startling claim . . . but it's true! You'll find the revolutionary Hartzell Controllable Pitch Fan will reward you with continuous operating efficiency and economy in many ways and for many years to come. Here's how!

**COOLING MAGIC** is accomplished by variable blade pitch settings that are instant and automatic. The fan holds outlet temperature fluctuation to ±1½° F by increasing or decreasing blade pitch as the cooling requirements change.

**UP TO 50% POWER SAVING.** Because the pitch of the fan blades is rarely at a maximum, considerable savings in power consumption is made. In fact, a Hartzell Controllable Pitch Fan may save more than enough in power to pay for itself.

**COMPLETE SIZE RANGE** from 7 to 12-foot diameters in four and six blade assemblies are made from Hartzite plastic, a Hartzell exclusive, and aluminum—available in 7 to 10-foot diameters.

**So if you want to be REWARDED with efficiency and economy for years to come, call on your Hartzell field engineer, or write for bulletin A-111B on Hartzell Controllable Pitch Fans for heat exchangers. You'll be glad you did.**

HARTZELL HARTZELL

A Division of Castle Hills Corp. **PROPELLER FAN CO. Piqua, Ohio**

PROPELLER TYPE FANS AND BLOWERS • ROOF VENTILATORS • UNIT HEATERS • ENGINEERING OFFICES IN PRINCIPAL CITIES


## Who's Building . . .

work required to prepare the unit for operation.

Primary purpose of the new structure is to increase the refinery's capacity for producing specialty solvents.

**American Petrofina, Inc.'s** platformer at the company's El Dorado refinery has been completed. The unit was built by the Petrofina staff. Original construction was begun in 1956, but was delayed to permit the fulfillment of jet fuel contracts. The platformer uses a UOP process.

**Monsanto Chemical Co.** has completed new facilities at Springfield, Mass., for manufacturing rubber-modified styrene. The expansion, begun last fall, has more than doubled the company's capacity to produce the plastic in medium-impact and high-impact formulations.

**International Refineries, Inc.** has completed a catalytic condensation unit at its Wrenshall, Minn., refinery.

Feed capacity is 1,150 bpsd of light olefins derived from catalytic cracking. This plant is an expansion of the refinery's former unit. Engineering and construction of the project was handled by Universal Oil Products Co.

**SunOlin Chemical Co.** formed last fall as a subsidiary company by Sun Oil Co. and Olin Mathieson Chemical Corp. is planning to build a urea plant adjacent to Sun's Marcus Hook, Pa., refinery, which will supply ammonia for the new unit. A contract has been let for construction of a building to be used initially for construction purposes of the SunOlin urea project, and later to house administrative and operating staffs of the company.

**Hess, Inc.** has reported construction of a refinery in the New York Harbor area—the first to be built there in many years. The 45,000-bpd plant, which at last reports was to have gone on stream before the end of the year, is located at Sewaren. The refinery has a five-million-barrel storage capacity for crude and products.

**Jefferson Chemical Co., Inc.** has completed a new ethylene plant at Port Neches, Texas. It will reportedly triple the company's production capacity for ethylene. An over-all expansion program will double capacity for ethylene glycol, increase by 50 percent production of ethylene oxide, and open fields based on ethylene and propylene for the company.

Also completed is a direct oxidation plant for ethylene oxide. Later, a chlorine-caustic unit will go on stream with an ethylene glycol plant. Completing the expansion next summer will be propylene glycol and propylene oxide units. When on stream the plant will operate as follows:

The refinery gas stream from The Texas Co., Port Arthur, is cracked in the ethylene unit, and ethylene and propylene recovered and purified. Ethylene will go to the direct oxidation unit to make ethylene oxide which in turn will lead to oxide adducts, the ethanolamines and antifreeze glycol.

The caustic-chlorine plant will serve the existing chlorhydrin plant. Part of this unit will produce propylene oxide.

The ethylene glycol unit will produce

# NOW 12

## *Proven Programs! Two new uses added to the IBM small refinery engineering package for the IBM 650*

Mobil

Magnolia

76 UNION

BONNER & MOORE ENGINEERING ASSOCIATES

IBM Fortransit

WARREN

IBM SOAP II

SHELL

**Powerful aid to small refineries**

Twelve customer-tested programs are now available without cost to small refinery users of the IBM 650 system. These packaged programs permit every refinery to obtain the advantages of electronic computing immediately.

**Yours . . . five years of engineering programming effort**

Due to the full cooperation of the petroleum industry, whose extensive experience at more than sixty IBM 650 installations has made these programs possible, you can now get five years of programming effort . . . packaged and ready for your use.

**The twelve programs now in the package are listed below:**

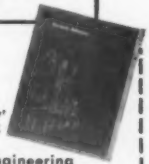
1. Plate-to-Plate Distillation Program
2. Bonner's Short Cut Distillation Program
3. Union Oil's Heat Exchanger Program
4. Magnolia's Linear Program
5. Shell's Regression Analysis Program
6. Pipe Stress Analysis Program (with procedures for handling up to eight anchors)
7. Benedict Equations
8. Interpretive Routine
9. IBM Fortransit
10. IBM SOAP II
11. Warren Absorber Calculation
12. Shell Equilibrium Flash Calculations

**Booklet describes programs in package**

SEND for the new booklet, "Proven Engineering Programs for Petroleum Refineries." Get detailed explanations of how all 12 of these powerful engineering programs can benefit your operations.

IBM 650 Magnetic Drum Data Processing System

IBM® DATA PROCESSING



PETROLEUM DEPARTMENT A58-e,
International Business Machines Corporation,
590 Madison Avenue, New York 22, New York

Please send me the free booklet, "Proven Engineering Programs for Petroleum Refineries" using the IBM 650.

Name _____

Position _____

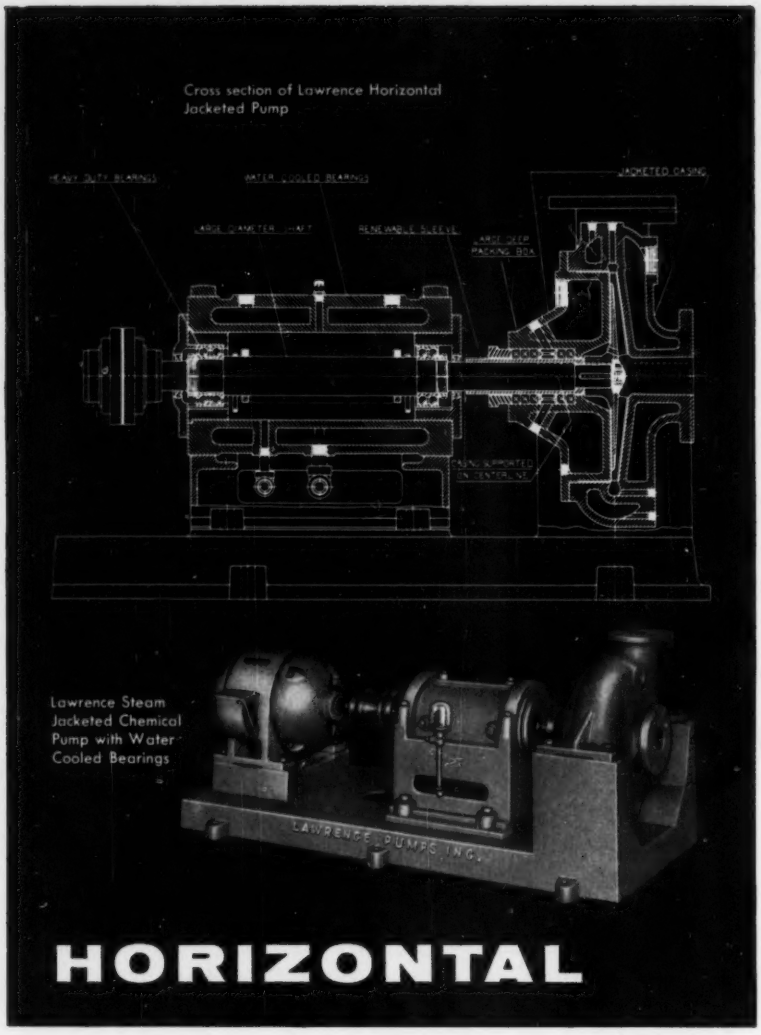
Company _____

Address _____

City _____ State _____



For more data on advertised products, use Readers' Service Cards, last page.




## jacketed PUMPS

Lawrence jacketed pumps are designed to pump liquids such as sulphur, phthalic anhydride, resins, waxes, etc., which tend to solidify or become viscous at low temperatures. The heating medium can be steam, dowtherm, etc., and all heating spaces are vented and self-draining.

The bearings are heavy-duty, water-cooled. Misalignment and distortion, which might be caused by thermal expansion, are eliminated by supporting the casing along the center line of the shaft.

If you have to pump liquids which must be held above a specified temperature to retain their fluidity, write us the pertinent details. No obligation.

**Write for Bulletin 203-7.**

**LAWRENCE PUMPS INC.**
371 Market Street, Lawrence, Mass.


## Who's Building...

industrial grade ethylene glycol, and part of this unit will process propylene oxide into propylene glycol.

Partial capacity of the existing ethylene plant will be used for liquid petroleum gas.

**British Hydrocarbon Chemicals, Ltd.** expects to more than double its olefin capacity by the installation of a third ethylene plant at Grangemouth, Scotland, scheduled for completion by mid-1960.

Production of ethylene and other olefins commenced in 1951, and was expanded in 1956 with the completion of a second unit. The company says the new plant will be the largest of its kind outside the United States and will be bigger than any other such plant built so far in Europe. Design and construction was handled by Stone & Webster Engineering Corp.

**Montecatini Co.** has contracted with the Iranian government for construction of a nitrogen fertilizer plant near Shiraz. The $30 million plant and pipeline will use natural gas as a raw material. Initial plans call for production of 110 tons per day.

**Ashland Oil & Refining Co.** will construct a new aliphatic solvent plant at its Leach refinery, Catlettsburg, Ky. It will produce specialty jet fuels also. Completion of the plant is slated for early this summer.

**Air Reduction Chemical Co.** has launched a $12 million construction program for erection of a polyvinyl alcohol resin plant at Calvert City, Ky. Construction is underway, with completion planned for early 1960. The 10,000-ton-per-year plant is being constructed by The Lummus Co.

**Cumberland Chemical Corp.,** a new company formed by Air Reduction Co. and The Mastic Tile Corp. of America, will build a $10 million plant at Calvert City, Ky., to produce vinyl chloride monomer, vinyl chloride polymer, and a new-type plasticizer. Blaw-Knox Co. is handling construction, with completion expected by early 1960.

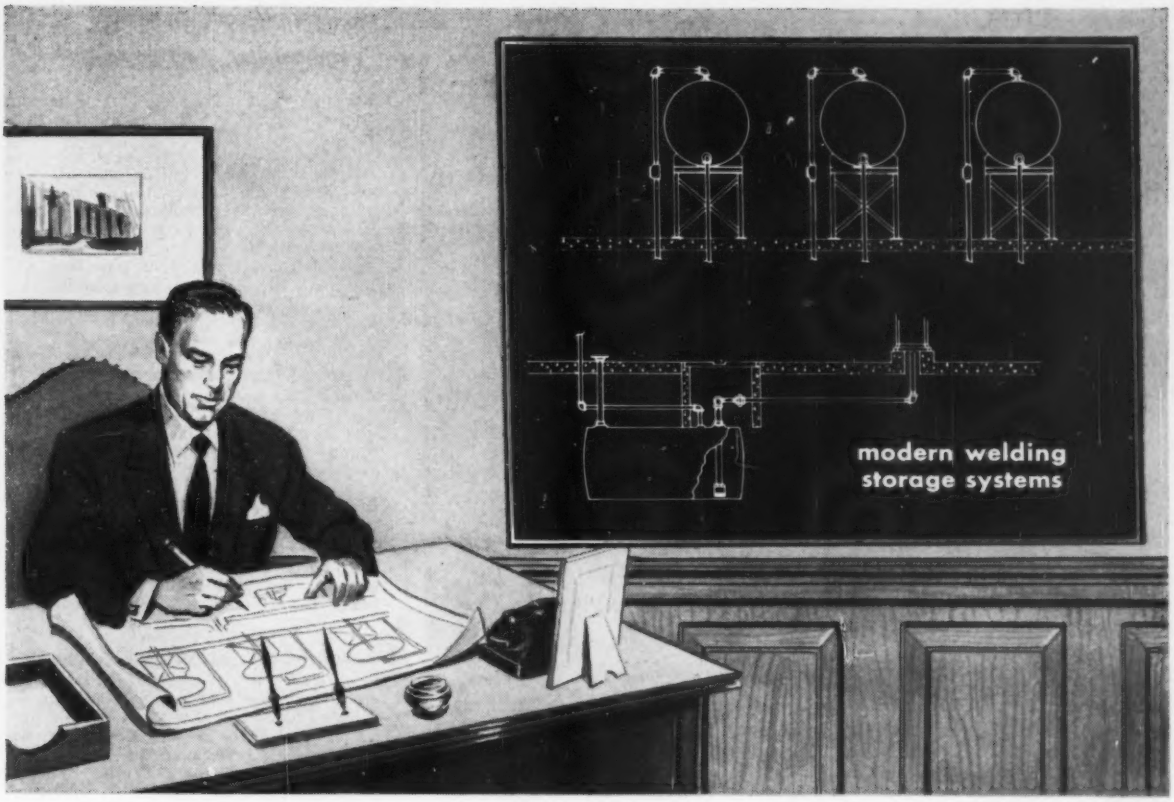
**Reichold Chemicals, Ltd.** is ready to build a sizable phenol plant and formaldehyde unit at its Port Moody, B.C., location The company also plans to build another phthalic anhydride plant at St. Terese, Quebec.

**Union Carbide Corp.** has purchased from Amoco Chemicals Corp. the utilizable facilities remaining on the 306-acre tract at Brownsville, Texas, site of the former Amoco processing plant. The option includes the 42-mile Weslaco-Brownsville natural gas pipe line. Union Carbide is negotiating a long-term lease with the Brownsville Navigation District (Port of Brownsville) for the Brownsville tract.

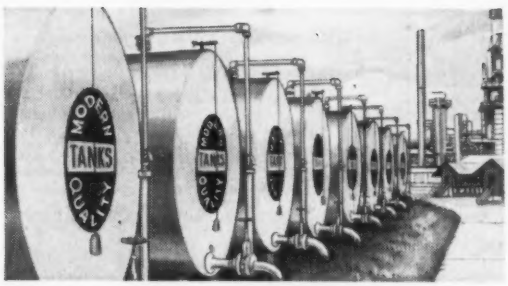
Engineering studies will be made for additions and revisions at the site. Utilization of facilities will be deferred for this reason, and also will depend upon completion of satisfactory arrangements for fuel gas and raw material supply. Union Carbide Chemicals Co. and Union Carbide Olefins Co. will use the site.

The project was originally designed and built by Carthage Hydrocol, Inc., to pro-


For more data on advertised products, use Readers' Service Cards, last page.




# efficient storage is our business




How many tanks, where they are to be placed, vertical or horizontal, above ground or below. Whatever your storage problem may be, we are prepared to handle it from start to finish. We have the personnel, the experience and the engineering know-how to analyze your requirements and to design and fabricate the equipment to meet them.

Just fill out the coupon below and drop it in the mail. Your storage problem will then be our professional responsibility.

MODERN TANKS QUALITY

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For more data on advertised products, use Readers' Service Cards, last page.

TWO SUPERIOR
SHEET PACKINGS . . . .
for petrochemicals
Belmont TEFLON*
Inert to all chemicals (excepting molten alkali metals and fluorine at elevated temperatures).
Available in sheet thicknesses from ½" up, and in sheet sizes from 24" by 24" to 48" by 48". Tape is available in continuous rolls in thicknesses from .005 up and in widths up to 12 inches.
Cut gaskets to specification and envelope gaskets with compressible filler materials for all standard pipe flanges. Write for catalog.
*du Pont Trademark
for oils and solvents
Belmont NEOPRENE
Belmont Neoprene sheet packing has high resistance to petroleum products, alcohol, caustics and many acids. It has high tensile strength and has good abrasion resistance.
Available in standard rolls, 40" wide by 10 yards long, in thicknesses from ½" to ¼" inc. and in durometer hardness of 40, 50, 60, 70, 80 and 90. Also available in cut gaskets.
ask your
BELMONT
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Such leading Packing Distributors as:
Mill & Industrial Supplies, Inc. in Louisville
and
Sterling Rubber Products Co. in Dayton
are ready to serve you promptly and helpfully, wherever you are.
Write for Catalog 56.
The Belmont Packing & Rubber Co.
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## Who's Building . . .

duce synthetic gasoline, other petroleum fractions and co-product chemicals from natural gas by the Fischer-Tropsch process. It was acquired by Amoco in 1954 and operated until last fall. Union Carbide says it does not plan to produce synthetic gasoline, petroleum products or Fischer-Tropsch-process chemicals.

The Brownsville plant will receive natural gas through a 16-inch pipe line, and the plant and the storage terminal are near deep water. The chemical processing operation at Brownsville will be Carbide's third Texas chemical facility.

**Amoco Chemicals Corp.** is reportedly planning to produce phthalic, isophthalic and terephthalic acids during the first quarter of this year. The company is said to have been making mixed acids for about two months.

**Southwestern Agrochemical Corp. and First Mississippi Corp.** plan to build a 60-ton-per-day anhydrous ammonia plant in Chandler, Ariz. Chemical Construction Co. is designing the $4 million plant. Construction will begin early this year.

**Reichold Chemicals, Inc.** is planning to build a plant at Niort, France, to produce 73,000 tons per year of formaldehyde. Reichold's second European formaldehyde plant, it will be built by Reichold-Beckasite, a company affiliate. Future plans call for the production of pentaerythritol.

**Aurora Gasoline Co.** is adding a sulfuric acid alkylation unit, auxiliary units, and offsite facilities at its Detroit refinery to increase its high-octane gasoline capacity. It will process 2,000 bpd of debutanized motor alkylate. Major vessels will be sized for ultimate capacity of more than 3,680 bpd. The refinery Engineering Co. of Tulsa will supply the process, mechanical design, engineering and construction.

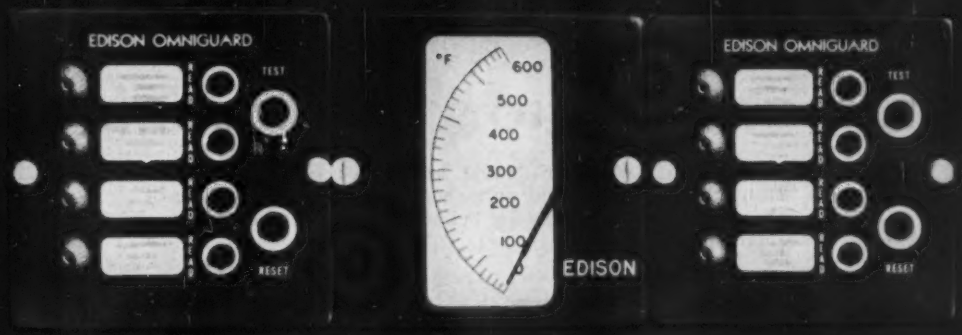
**Ketjen Carbon, Ltd.,** a new company formed by Royal Sulphuric Acid Works, Amsterdam, Holland, plans to build a carbon black plant in the Netherlands. Ketjen Carbon has entered a license agreement with Godfrey L. Cabot, Inc., Boston, for patent rights and technical advice. The Dutch facility will be built in the western part of the Botlak area of Rotterdam. It will produce 13,000 tons of carbon black annually, and a full range of furnace blacks to the rubber industry.

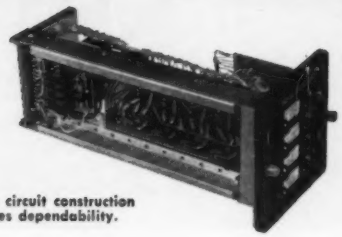
**Borden Chemical Co.** is planning to build a 5-million-pounds-per-year polyvinyl alcohol plant to adjoin the company's present plant in Leominster, Mass. It is slated for completion in October. A new Borden-developed and engineered process will be employed, according to the company. It reportedly assures high-quality production of polyvinyl alcohol in all grades and viscosities on a continuous basis.

**Lindum Fibers Corp.,** the new subsidiary of Celanese Corp. and Imperial Chemical Industries, Ltd., will build a 40-million-pound-per-year polyester fiber plant at a yet unchosen site in the United States. The plant is expected to go on stream within 18-24 months, and should reach the 40-million pound mark within five years.

The Celanese-ICI project is the first to announce that it will make and market in

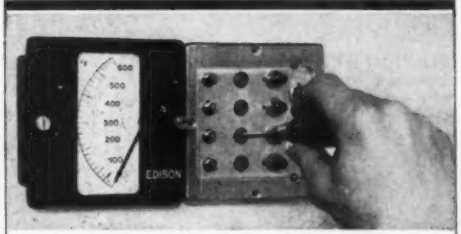

For more data on advertised products, use Readers' Service Cards, last page.



Printed circuit construction increases dependability.

Highest quality components, with no moving parts, assure maintenance-free operation.




Easy access to all components permits quick temperature settings and monitoring system changes – at any time.

Model 310 Edison Omniguard with Model 311 Indicator – a single indicator can read any number of temperature points.

THOMAS A.

# EDISON

## new model 310 omniguard temperature monitor... unmatched for versatility

The new Model 310 Edison Omniguard provides the simplest, most dependable temperature detection system yet devised... for both small and large installations.

The Omniguard system is reliable... flexible... economical. You order only the plug-in units needed, add new units as your monitoring needs expand.

Check these features of the new Edison Omniguard:

**1. VERSATILE:** One instrument can be used for both normally open and normally closed annunciator... for alarm or for shutdown of equipment.

**2. FLEXIBLE:** Quick, inexpensive system changes and additions . . . easy tie-in with any type annunciators or cut-off switches.

**3. DEPENDABLE:** Rugged design with highest quality components, no fragile moving parts.

**4. SIMPLE:** Single indicator reads any number of temperatures, needs no periodic adjustment. With a minute's briefing, *anyone* can operate the simple Omniguard monitoring system.

**5. LOW COST:** Plug-in units can be custom-tailored to your exact requirements . . . order additional units only when needed.

## Thomas A. Edison Industries

**INSTRUMENT DIVISION**

**96 LAKESIDE AVENUE, WEST ORANGE, N. J.**

McGRAW EDISON

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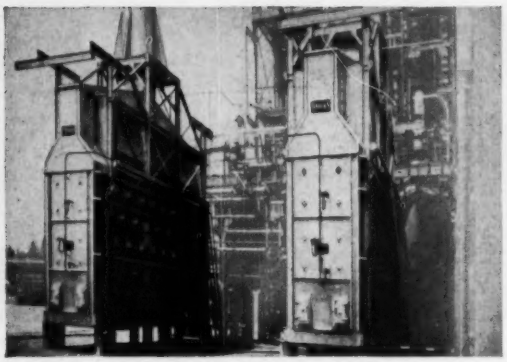
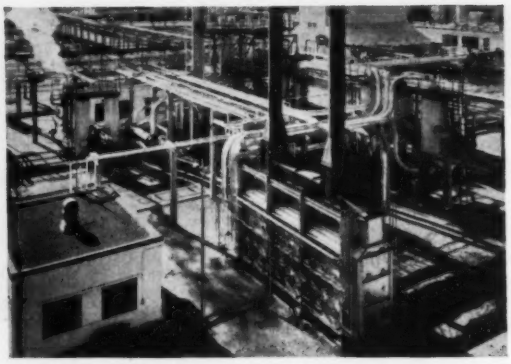
# SELAS

## HORIZONTAL GRADIATION® FURNACES

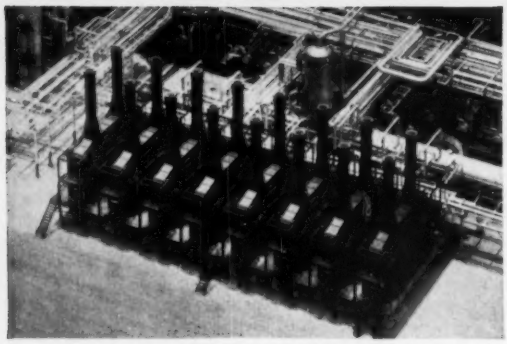
are in service wherever critical heat processing is required throughout the petroleum, petrochemical and chemical industries. The installations shown below demonstrate the benefits of Gradiation heating:



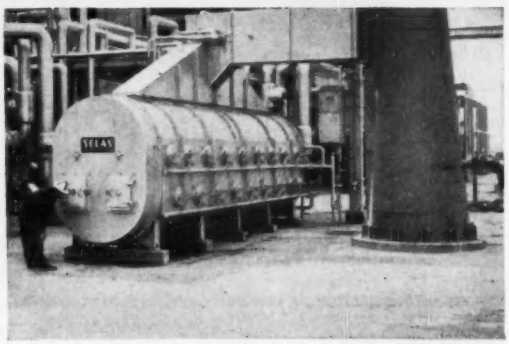
**PRECISENESS OF HEATING . . .** is essential in the continuous production of Carbon Bisulfide to assure that tube wall temperature is uniform throughout the entire radiant section.



**ZONE CONTROL and INSTANT RESPONSE TO CONTROLLER DEMAND . . .** permit the use of three independent coils in a single heater in this Catalytic Reforming operation.



**ABILITY TO HANDLE A VARIETY OF FEED STOCKS IN ONE HEATER . . .** each individual heater in this Ethylene installation is capable of handling ethane, propane, butane or naphtha, interchangeably, under optimum conditions.

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The same benefits of Gradiation heating:

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have been extended to

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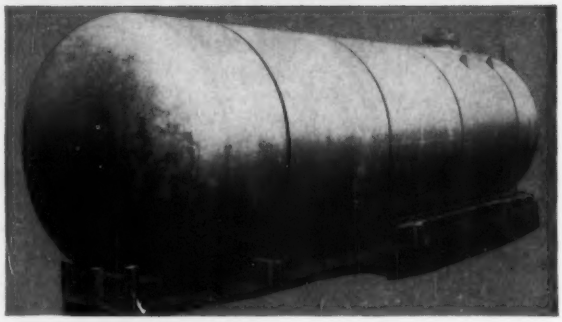

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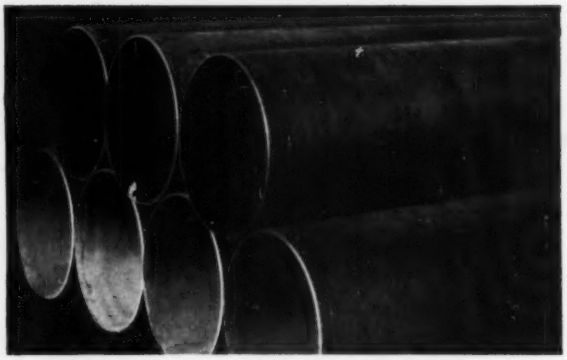

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## Who's Building...

the United States a commercially established polyester fiber of the same chemical composition as E. I. duPont de Nemours & Co.'s Dacron. Du Pont's original patents on Dacron expire in 1961.

**Mitsui Petrochemical Industries, Ltd.** has completed a commercial terephthalic acid plant at Iwakuni City, Japan. The facility, which operates on petroleum-based feedstocks, uses Scientific Design Co.'s liquid-phase air-oxydation process. It is an addition to Mitsui's $30 million petrochemical project.

**Cobenam, S.A.,** a newly formed Belgian subsidiary of Union Carbide Corp. and the Belgian Company, Societe Chimique des Derives du Petrole S.A., Petrochim, plans to construct a 30-million-pound-per-year polyethylene plant near Antwerp. Production will begin in mid-1960.

**Honduras** recently signed a contract with International Industries of N. J. to build a $15-$20 million oil refinery in the Fonseca Gulf area. The 15,000-bpd plant is planned to eventually cover the entire Central American market.

**Chile** plans new refineries at Antofagasta and Concepcion similar to its Concon installation. Oil would be refined from new wells discovered in Magallenes. Crude oil would be treated and transported by a pipeline which will connect Sicasica in Bolivia with Arica. The M. W. Kellogg Co., which installed the Concon plant, will build, install and operate the new refineries.

**American Cyanamid Co.** plans to double the acrylonitrile capacity of its plant near New Orleans, bringing it to 100-million tons per year.

**Monsanto Chemicals, Ltd. (Australia)** plans to build Australia's first styrene monomer plant. The $4.5 million Sydney plant is planned for completion in 1960.

**Cities Service Oil Co.'s** $27 million refinery at Bronte, Ontario, has been completed. The 20,000-bpd plant was completed four months ahead of schedule.

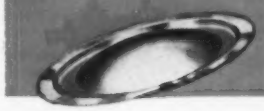
**Savannah Terminal, Inc.** is building a $500,000 asphalt plant in Savannah, Ga. Scheduled to begin operation in the first quarter of this year, the unit will have a 500,000 gallon storage capacity. Raw materials will be provided by Shell Oil Co.

**Mississippi Chemical Corp.** is planning a $1.5 million urea plant, and will spend $650,000 for expansion of anhydrous ammonia facilities of Coastal Chemical Corp., its subsidiary.

**British Petroleum Co., Ltd.** has begun work on a new refinery in the Ruhr area of Germany. It will be built on a 600-acre site near Dinslaken, some 15 miles north of Duisburg, and will have a throughput capacity of 100,000 bpd. Site clearance has started and the refinery is due to be completed before autumn, 1960.

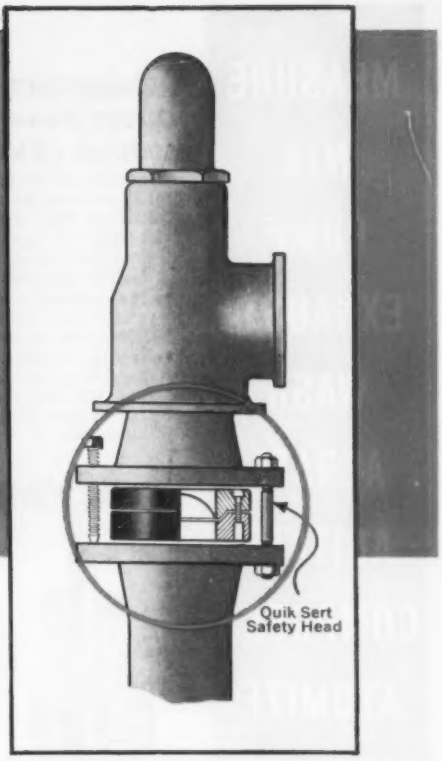
The main processing plants will be two crude oil distillation units, a catalytic reforming unit, a hydrofiner for desulfurizing gas oil, and two copper chloride units. A wide range of products will include


**You Can Prevent These Three Relief Valve Problems With a BS&B Quik-Sert *Safety Head!***



BEFORE

AFTER




**Leakage**
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**"Freeze-ups"**

The BS&B Quik-Sert Safety Head isolates the relief valve from the product under pressure. Mounted under the valve inlet, it is "bottle tight" until overpressure reaches the rated pressure of the preformed metal rupture disc.

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CIRCULATE
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***LIQUID LEVEL GAGES***

Designed with exclusive features for range of pressures, temperatures, corrosive conditions or other specific requirements.

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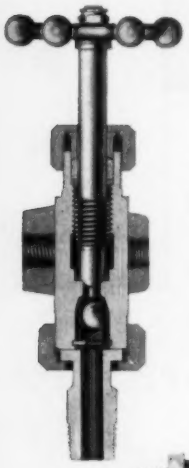

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Exclusive "floating shank" saves on installation, eliminates strains common to forced installations.

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## Who's Building...

gasoline, aviation turbine fuels, marine diesel oils, gas oils, fuel oils, and chemical works feedstocks. The petroleum chemical feedstocks will be supplied to new units being built for Erdoelchemie G.m.b.H., a joint company established by BP's German associates, BP Benzin und Petroleum A.G. and Farbenfabriken Bayer A.G. Crude oil for the new refinery will be drawn from the Wilhelmshaven/Ruhr pipe line, presently under construction.

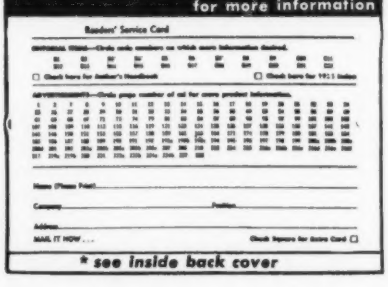
**Cuba** reports that Belgian businessmen are ready to invest $20-$30 million there to process oil from mineral asphalt, and would grant Cuba the right to buy out the investment, if desired. The republic has large deposits of natural asphalts in Mariel, Jarahueca and Oriente province. Major reserves are concentrated largely in Las Villas province and near Mariel where there are said to be about 800,000 metric tons of asphalt. A $2 million asphalt roofing plant is under construction in Camaguey. Production is expected to begin next May with planned output of some 6,000 asphalt sheets daily. The parent firm, Tejas Infinitas, will import operating machinery from the United States.

**E. I. duPont de Nemours & Co.** is planning an expansion program for its line of polyethylene and polyester film. Plans have been completed for construction of a low-pressure process linear polyethylene plant at its Sabine River works, Orange, Texas. Plans for the new facility call for it to go on stream by mid-1960. Cost and capacity figures have not been released by the company.

The company's plans for polyester film call for a 30 percent expansion of facilities at Circleville, Ohio. The company said capacity will be nearly double what it was at the plant's opening in 1954. Completion will be in 1960.

**Pakistan Industrial Development Corp.** has started construction of a new fertilizer plant at Multan in West Pakistan. The $32 million plant is being built in cooperation with a group of French firms who have undertaken the project on a turnkey basis. Deferred payment of approximately 75 percent of the total cost is provided in the agreement. The plant will use natural gas from the Sui field and is expected to produce 103,000 tons of ammonium nitrate and 52,000 tons of urea by the end of 1960.

use these
**READERS' SERVICE CARDS***
for more information



* see inside back cover

**TABLE I**

**Gas Processing Plants, Western Canada, November, 1958**

| PLANT LOCATION | PLANT OWNER | NOMINAL CAPACITY MMCFD RESIDUE GAS | PLANT PRODUCTS | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Propane | Iso Butane | Normal Butane | Total Butane | Natural Gasoline | Stabilized Condensate | Weathered Condensate | Sulphur | Other |
| British Columbia | | | | | | | | | | | |
| Taylor | Pacific Petroleums Ltd. | 300 | X | | | X | | | | X | (1) |
| Alberta | | | | | | | | | | | |
| Acheson | Progas Limited | 6 | X | | | X | X | | | | |
| Alexander | Mid-Western Industrial Processors | 50 | | | | | X | | | | |
| Bonnie Glen | Texaco Exploration Co. | 30 | X | | | X | X | | | | |
| Cessford | Hudson's Bay Oil and Gas Co. | 125 | | | | | | | X | | |
| | Canex Gas Ltd. | 22 | | | | | | | X | | |
| Devon | Imperial Oil Ltd. | 24 | X | | | X | X | | | | |
| Jumping Pound | Shell Oil Co. of Canada Ltd. | 80 | | | | | | X | | X | |
| Pembina | Goliad Ltd. | 80 | X | X | X | | X | | | | |
| | Texaco Exploration Co. | 8 | | | | | X | | | | (2) |
| Pincher Creek | British American Oil Co. | 85 | X | | | X | X | X | | X | |
| Princess | The California Standard Co. | 12 | | | | | | | X | | |
| Provost | Provo Gas Producers Ltd. | 44 | | | | | X | | | | |
| Redwater | Imperial Oil Ltd. | 11 | X | | | X | X | | | X | |
| St. Albert | Ajax Petroleums Ltd. | 20 | | | | | X | | | | |
| Samson | Western Leaseholds Ltd. | 3 | | | | | | | X | | |
| Stettler-Fenn-Nevis | British American Oil Co. | 18 | X | | | X | X | | | | |
| Turner Valley | Anglo American Exploration Ltd. | 10 | | X | | | X | | | | |
| | The British American Oil Co. Ltd. | 20 | | | | | X | | | | |
| | Royalite Oil Company Ltd. | 85 | X | | | | X | | | X | |
| Saskatchewan | | | | | | | | | | | |
| Coleville | Saskatchewan Power Corp. | 60 | | | | | X | | | | |
| Smiley | Imperial Oil Ltd. | 3 | | | | | | | X | | |
| Steelman | Steelman Gas Ltd. | 25 | X | X | X | | X | | | X | |

(1) Gasoline Blending Stock, Naphtha, Kerosene and Diesel Fuel.

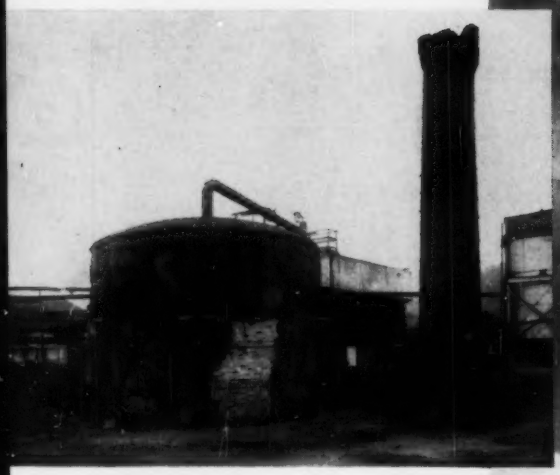
(2) $C_3$—$C_4$ Mix.

"Construction Boxscore" data reveal . . .

# More Gas Plants Seen for West Canada

## Recent expansion of gas distribution systems makes Western Canada's gas processing outlook bright

Within the past several years, "Construction Boxscore" has recorded a continuing growth of gas processing plants in Western Canada. Until recently most of this construction has been the result of gas conservation with the plant residue being marketed locally. However, with the completion of the Westcoast Transmission Co., Ltd., and the Trans-Canada Pipe Lines, Ltd., large diameter lines to the West Coast and to Eastern Canada respectively, plant construction is proceeding in the majority of the fields scheduled to supply gas to



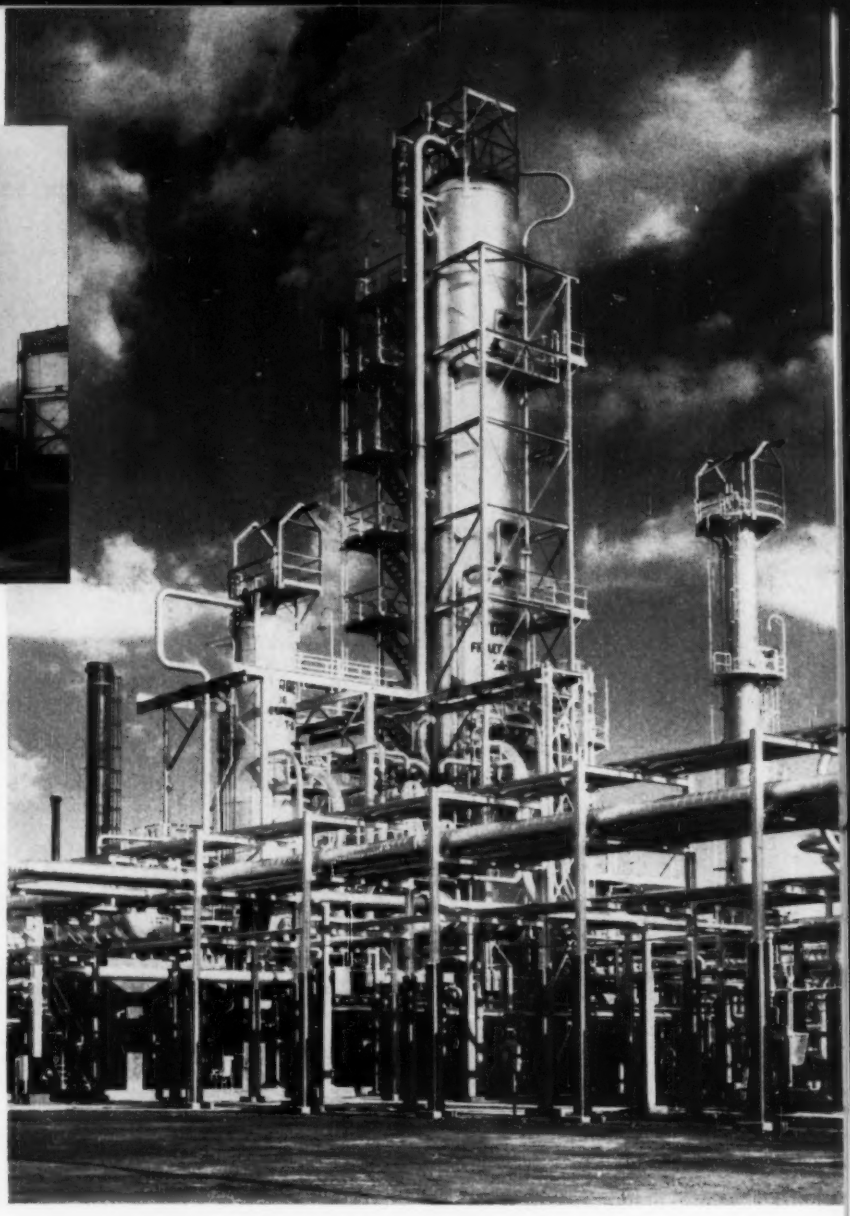
**PETROLEUM REFINERY—CIRCA 1865**

This Cheese Box Still was a "large-scale" refinery in the early days of petroleum, employing the most up-to-date process known at that time.

**PETROLEUM REFINERY—1958 STYLE**

The brick foundations and chimneys of earlier days have long since given way to the modern design and construction seen in this atmospheric crude distillation unit.

McKee is now building one of the largest, if not *the* largest crude processing unit in the world. With a capacity of 140,000 barrels-per-stream-day, it will be capable of processing twice as much crude in a year as *all the wells in America* produced in the first ten years of the industry's history.



## The Profit-Making Life of a Refinery depends on its *ENGINEERING*

McKEE builds plants that are designed and constructed to earn profits for years to come. McKee engineers have no magic ability to *see* into the future, but they *do* have the ability to *plan and build* for the future. Basically, this is the result of two things: constant improvement of design techniques and construction methods; and a half-century fund of practical, world-wide experience upon which to draw.

We believe it will pay you well to consult McKee on your new plant project or plant expansion program.

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these lines. As a result of the rigid hydrocarbon dewpoint specifications required by the pipe line companies, most of the gas purchased, including that from so called "dry gas" fields, will require some processing.

Table 1 is a tabulation of the gas processing plants which are presently operating or are scheduled to be in operation shortly. The table shows the plant location, plant owner, nominal capacity in terms of pipe line gas and a check list of the types of by-products being manufactured. The data has been compiled from previously published information where possible. It indicates that present plant capacity totals some 1100 MMcfd. Plans for plant construction for the processing of gas in other now known fields could double this figure within the next five years.

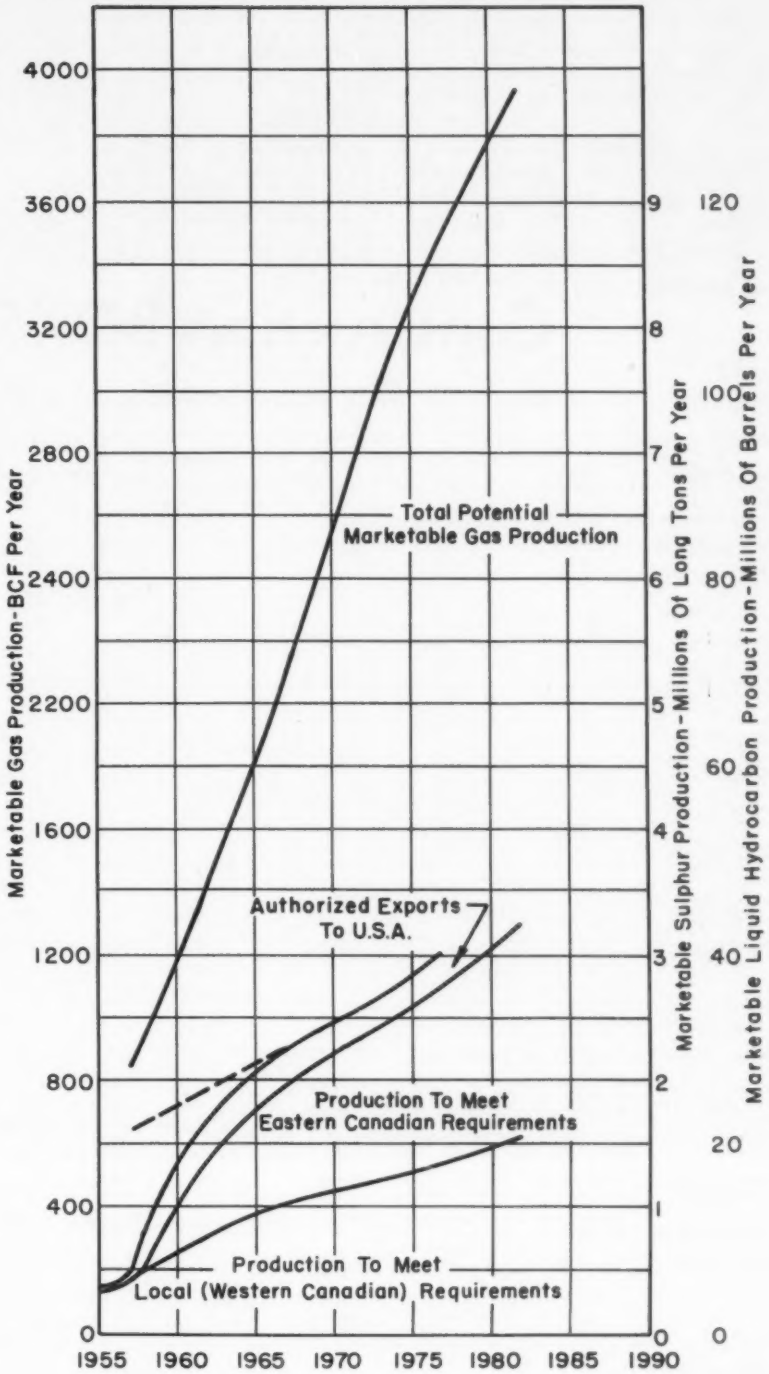
**Processing By-Products.** From production reports filed by gas processing plants in Alberta, from available gas analyses and from published reports, these data have been compiled into an accurate estimate of the current reserves of plant by-products. Table II is a summary of the estimated reserves as of Dec. 31, 1957, consistent with the reserves of natural gas.

In cases where actual plant performance data are not available, reserves were estimated by assuming recoveries from the raw gas streams of 50 percent propane, 90 percent butanes and 100 percent pentanes and higher hydrocarbons. In the case of gas condensate fields, estimated condensate production was included in the pentanes plus figure.

**Rough Estimates.** It would be much too hazardous to attempt to predict, with any degree of accuracy, the annual rates of plant by-products production. There is a wide variation in analyses of the different reserves of gas which will require processing. The plant construction schedules will of course depend on pipe line construction and whether or not additional outlets for the residue gas are found. However, if we wish to exercise our imagination a little more, a very rough estimate can be made.

Assuming that the ratio of liquid hydrocarbon and acid gas components to total gas reserves will on an average remain constant, we may use the upper curve of Figure 1. By assuming a 25-year uniform rate of production for the by-products associated with the presently established reserves and for reserves to be discovered in the future, we then place suitable scales on the ordinate of Figure 1. This gives a direct conversion of estimated gas production to estimated liquid hydrocarbon and

**An estimation of future liquid hydrocarbon and sulfur production is shown by the upper curve in this plot.**



sulfur production by years. The graph indicates that in the year 1982 the annual production of liquid hydrocarbons and sulfur could be as great as 135-million barrels and 10-million long tons respectively. This compares to the current United States production of some 300-million barrels and 7-million long tons respectively.

Condensed from "Gas Potential of Western Canada," a paper presented at the Rocky Mountain Regional Meeting of the NGAA September, 1958, by Jack G. Stabback.

**TABLE II**

**Estimated By-Product Reserves, Western Canada—December 31, 1957**

| Component | Millions of Barrels | | | |
|---|---|---|---|---|
| | British Columbia | Alberta | Saskatchewan | Total |
| Propane | 4.8 | 170 | 19.3 | 194.1 |
| Butane | 8.3 | 166 | 12.9 | 187.2 |
| Pentanes plus | 17.2 | 290 | 7.8 | 315.0 |
| Total liquids | | | | 696.3 |
| Sulphur, long tons x $10^6$ | 2.7 | 50 | 0.1 | 52.8 |

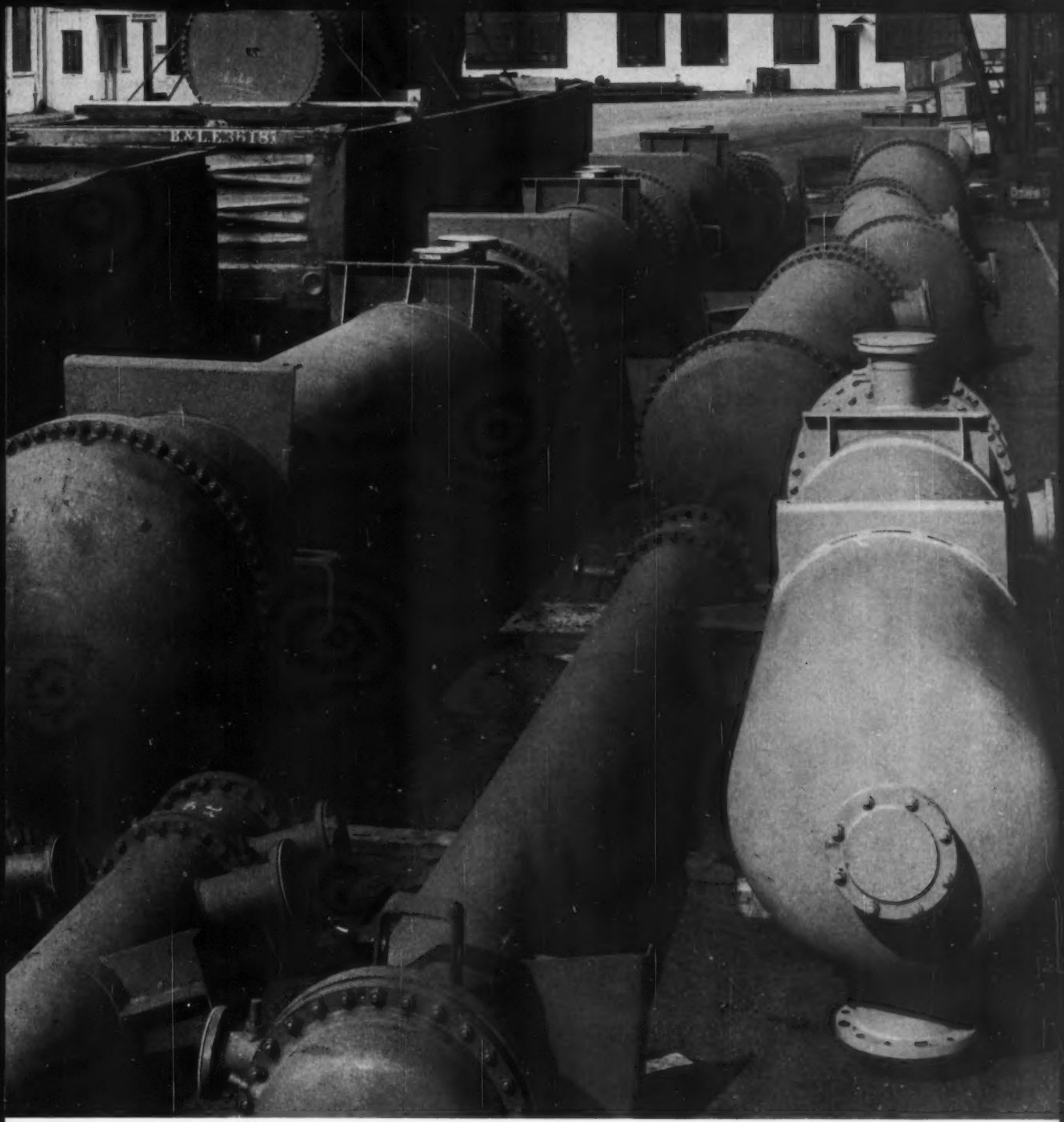
# Construction BOXSCORE

## OIL, GAS AND PETROCHEMICAL PROCESSING PLANTS

| COMPANY | Plant Site | Project | Daily Capacity | Estimated Cost | Status | Probable Completion | Licensor | Engineering | Contractor |
|---|---|---|---|---|---|---|---|---|---|
| **EAST** | | | | | | | | | |
| **Allied Chemical & Dye** | **Buffalo, N.Y.** | **Polyethylene** | ..... | ..... | Under Constr. | ..... | ..... | ..... | ..... |
| American Cyanamid | Bridgeville, Pa. | Maleic Anhydride | 14,000,000 lbs/yr | ..... | Under Constr. | ..... | Scientific Design | Scientific Design | Scientific Design |
| Atlantic Refining | Philadelphia | Vacuum Flash Unit | 40,000 bbls. | ..... | Under Constr. | Spring, 1959 | ..... | Hydrocarbon Research | Hydrocarbon Research |
| | | Revamp Visbreaker | 20,000 bbls. | ..... | Under Constr. | Spring, 1959 | ..... | Atlantic | Atlantic |
| **California Oil Co.** | **Perth Amboy, N.J.** | **Cat. Reformer and Desulfurizer** | **10,000 bbls.** | **$7,000,000** | **Under Constr.** | 1st Qtr., 1959 | ..... | **Ferguson** | **Ferguson** |
| **Chemstrand** | **Decatur, Ala.** | **Exp. Acrilan Plt.** | **45,000,000 lbs./yr.** | ..... | **Under Constr.** | ..... | ..... | Staff, et al | Davis Constr. |
| Coastal Chemical | Pascogula, Miss. | *Ammonia | 200 tons | $6,650,000 | Under Constr. | 1959 | ..... | Chemico | Chemico |
| **Columbia Hydrocarbon** | **Siloam, Ky.** | **Hydrocarbon Fractionation Plt. with pipe line and off-site facilities** | **230,000,000 gal./yr.** | **$5,000,000** | **Under Constr.** | ..... | ..... | **Pritchard** | **Pritchard** |
| **Commerce Oil Ref.** | **Jamestown, R.I.** | **Refinery:** | **40,000 bbls.** | | | | | | |
| | | **Crude Units** | **25,000 bbls.** | **$50,000,000** | Engineering | ..... | **UOP** | **Fluor** | **Fluor** |
| | | **Cat. Cracking** | ..... | | | | | | |
| **du Pont** | **Belle Works, W. Va.** | **Urea; Ammonia Methyl Methacrylate, Nylon Intermediates** | ..... | ..... | **Planned** | **1959** | **Texaco** | ..... | ..... |
| | New Jersey | Hydrogen Plant | ..... | ..... | Engineering | ..... | ..... | Chemico | Chemico |
| **Esso Standard** | **Bayway, N.J.** | **Hydrofiner** | **15,000 bbls.** | ..... | ..... | ..... | ..... | ..... | ..... |
| Goodrich-Gulf Chem. | Institute, W.Va. | Rubber Production Exp. | ..... | $1,000,000 | Complete | ..... | ..... | Girdler, Staff | Girdler |
| Goodyear | Point Pleasant, W. Va. | *Polyesther Resin | ..... | $10,000,000 | Under Constr. | Early, 1959 | ..... | Catalytic | Catalytic |
| **Gulf Oil** | **Near Charleston, S.C.** | **Refinery** | ..... | ..... | **Considering** | ..... | ..... | ..... | ..... |
| Hercules | Hopewell, Va. | *Caprolactam Monomer Expansion | 60,000,000 lbs/yr. | ..... | Under Constr. | ..... | ..... | ..... | ..... |
| Hess | Perth Amboy, N.J. | *Unifiner-Platformer | 5,000 bbls. | ..... | ..... | ..... | ..... | ..... | ..... |
| | | *No. 2 Fuel Oil Unifiner | 5,000 bbls. | $1,500,000 | Under Constr. | ..... | UOP | Treco | Treco |
| Olin Mathieson | Model City, N.Y. | *Hydrogen Plt. | ..... | ..... | Complete | ..... | ..... | Girdler | Girdler |
| **Reichhold Chemicals** | **Hampton South Carolina** | **Formaldehyde Plant** | **30,000,000 lbs./yr.** | ..... | **Engineering** | ..... | ..... | ..... | ..... |
| | **Tuscaloosa** | **Formaldehyde Plt.** | **35,000,000 lbs./yr.** | ..... | **Planning** | ..... | **Staff** | **Staff** | **Staff** |
| **Socony Mobil** | **Paulsboro, N.J.** | **Alkylation** | **2,440 bbls.** | ..... | Under Constr. | ..... | ..... | **Kellogg** | **Kellogg** |
| | | **Delayed Coker** | **19,000 bbls.** | ..... | Engineering | **Early 1959** | ..... | ..... | **Lummus** |
| | | Sulfur Recovery Plt. | ..... | $700,000 | Under Constr. | ..... | ..... | Badger Mfg. | Badger Mfg. |
| | Buffalo, N.Y. | 2 Stage Crude Distl. Unit | ..... | ..... | Under Constr. | Early, 1959 | ..... | Lummus | Lummus |
| **Spencer Chemical** | **Henderson, Ky.** | **Urea Plt.** | **100 tons** | ..... | Complete | ..... | Montecatjn | **Staff** | **Quaker Valley** |
| **Union Carbide Chemicals** | **Institute, W.V.** | **Exp. Acrylonitrile Plt.** | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| | **Winfield, W.V.** | **Petrochemical Plt.** | ..... | ..... | **Planning** | **1960** | ..... | ..... | ..... |
| **United Fuel Gas Co.** | **Kenova, W.V.** | **Hydrocarbon Extraction Plt.** | ..... | **$9,000,000** | Complete | ..... | ..... | **Pritchard** | **Pritchard** |
| United Refining | Warren, Pa. | *Crude Unit | 15,000 bbls. | ..... | ..... | ..... | ..... | ..... | ..... |
| | | *Cat Reformer Revamp | 4,000 bbls. | ..... | ..... | ..... | ..... | ..... | ..... |
| | | *Unifiner | 5,000 bbls. | $1,500,000 | Complete | ..... | ..... | Staff | Staff |
| | | *Depentanizer | 5,000 bbls. | ..... | ..... | ..... | ..... | ..... | ..... |
| | | *Cat Cracker Revamp | 5,000 bbls. | ..... | ..... | ..... | ..... | ..... | ..... |
| **MID-CONTINENT** | | | | | | | | | |
| **Amoco Chemical** | **Joliet, Ill.** | **Phthalic Anhydride Isophthalic Acid, Terephthalic Acid, Diemthyl Terephthalate, Dimethyl Isophthalate Benzoic Acid** | **60,000,000 lbs./yr.** | **$10,000,000** | Complete | ..... | ..... | **Scientific Design** | Scientific Design |

* First appearance in tabulation. † Added capacity.

*Construction BOXSCORE Continued on Page 281*



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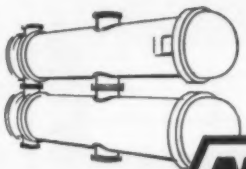

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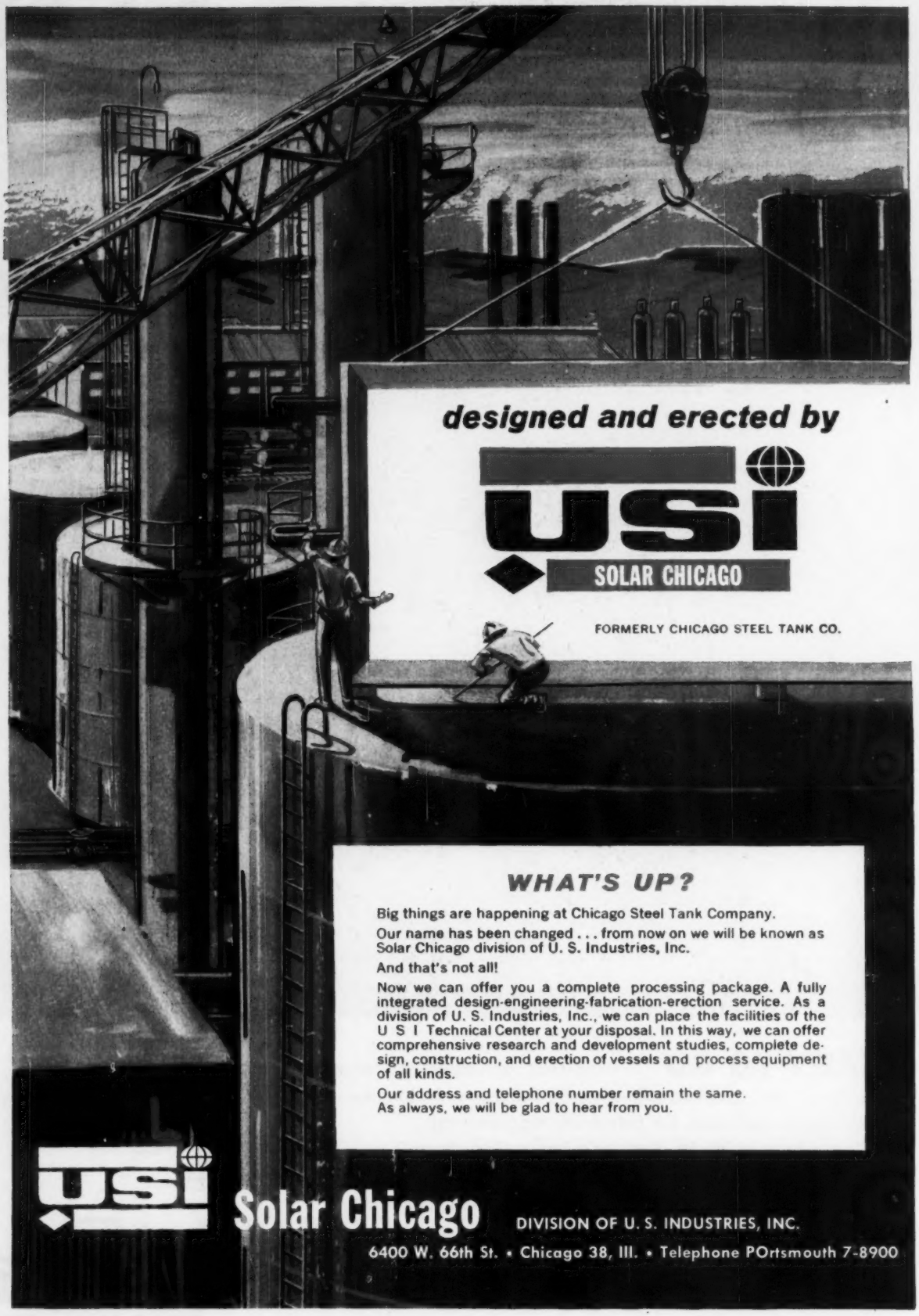
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## CONSTRUCTION BOXSCORE—*Continued*

| COMPANY | Plant Site | Project | Daily Capacity | Estimated Cost | Status | Probable Completion | Licensor | Engineering | Contractor |
|---|---|---|---|---|---|---|---|---|---|
| Aurora Gasoline Co. | Detroit | Vacuum Unit | 18,000 bbls. | ..... | Under Constr. | Early 1959 | ..... | Treco | Treco |
| Bay Refining Co., | Bay City, Mich | Crude Unit | 12,000 bbls. | $900,000 | Under Constr. | Mid-1959 | ..... | Sweco | Sweco |
| | | Butylene/Alky. Unit | 850 bbls. | 850,000$ | Under Constr. | Mid 1959 | UOP | Sweco | Sweco |
| Callery Chemical.... | Muskogee. Okla.. | Hydrogen Plt. | 800,000 scf | ..... | ..... | ..... | ..... | ..... | ..... |
| | | Carbon Dioxide | 7,790 lbs./hr. | ..... | ..... | ..... | ..... | ..... | ..... |
| Carter Oil Company.. | Billings, Mont. | Alkylation Plant | 2,300 bbls. | ..... | Under Constr. | May, 1959 | UOP | Treco | Treco |
| | | Convert Bauxide Desulfurising Unit to Hydrofiner. | 11,000 bbls. | ..... | Under Constr. | May, 1959 | Esso | Treco | Treco |
| Cities Service..... | East Chicago, Indiana | Cat Reformer | 7,500 bbls. | $4,000,000 | Under Constr. | ..... | UOP | Staff Procon | Procon |
| Cooperative Farm Chemicals | Lawrence, Kansas | Ammonia Urea | 100 tons/30 tons | $4,400,000 | Engineering | August, 1959 | ..... | Chemico | Chemico |
| Derby Refining..... | Wichita, Kansas | *Alkylation Unit | 1,700 bbls. | $1,500,000 | Under Constr. | May, 1959 | ..... | ..... | Procon |
| | | Waste Disposal | ..... | $500,000 | ..... | June, 1959 | ..... | ..... | Knighin Hughes-Litwin |
| Dow Chemical..... | Bay City, Mich.. | Petrochemical Plt. | ..... | ..... | Under Constr. | Summer 1959 | ..... | Bechtel | Austin |
| | | Polyethylene Plt. | ..... | ..... | Under Constr. | Summer, 1959 | Zeigler | Bechtel | Bechtel |
| Ethyl Corp..... | Joliet, Ill. | Antiknock Compounds | ..... | ..... | Planned | ..... | ..... | ..... | ..... |
| Goodyear Tire & Rubber | Point Pleasant, West Virginia | Polyester Resin | ..... | $10,000,000 | Planning | ..... | ..... | ..... | ..... |
| Grace Chemical Div. W. R. Grace & Co. | Memphis, Tenn. | Urea Expansion | 300 tons | ..... | Under Constr. | March, 1959 | ..... | Foster Wheeler | Procon Contracting Co. |
| Grand River Chem.. | Pryor, Okla. | Ammonia | 10-15 tons | $200,000 | Complete | ..... | ..... | Treco | Treco |
| Gulf Oil..... | Toledo | Alkylation Unit | 2,000 bbls. | ..... | Under Constr. | Feb., 1959 | ..... | Kellogg | Kellogg |
| Leonard Refineries... | Alma, Mich. | FCC Unit | 7,500 bbls. | $3,000,000 | Under Constr. | ..... | UOP | Parsons | Parsons |
| | | Alkylation Unit | 1,000 bbls. | $1,100,000 | Under Constr. | ..... | UOP | Parsons | Parsons |
| Lion Oil..... | El Dorado, Ark. | Unifiner—Platformer | 5,000 bbls. | $1,000,000 | Engineering | ..... | UOP | UOP Procon | Procon |
| Monsanto Chemical.. | Monsanto, Ill. | Phenol Plt. Exp. | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| | El Dorado, Ark. | Urea Plt. | ..... | ..... | Under Constr. | ..... | ..... | Chemico | Chemico |
| Naph-Sol Refining.... | Muskegon, Mich. | Exp. Crude Unit | 10,000 bbls. | ..... | ..... | ..... | ..... | Litwin | Litwin |
| Nat'l Coop Refinery. | McPherson, Kan | Revamp crude, coking, and alkylation units offsite Facilities | ..... | $1,700,000 | Complete | ..... | UOP | Staff Treco | Treco |
| Northwestern Ref. Co | St. Paul Park, Minn. | Cat. Reformer | ..... | ..... | Planning | 1959 | ..... | ..... | ..... |
| Ohio Oil..... | Robinson, Ill. | Revamp Houdriformer | ..... | ..... | Complete | ..... | ..... | ..... | Catalytic |
| | | Heater Addition to Delayed Coker | 1,400 bbls. | ..... | Under Constr. | ..... | ..... | Lummus | Catalytic |
| Pana Refining..... | Pana, Ill. | Unifiner | 1,870 bbls. | $1,000,000 | Complete | ..... | UOP | Procon UOP | Procon |
| Pennsalt Chemicals.. | Wyandotte, Mich. | Methylamines | ..... | ..... | Complete | ..... | ..... | J.D. Leonard Assoc. | Catalytic |
| Reichhold Chemicals. | Detroit | Formaldehyde Plt. | 35,000,000lbs./yr. | ..... | Planning | ..... | Staff | Staff | Staff |
| | Kansas City, Kan. | *Formaldehyde | 35,000,000 lbs/yr. | $500,000 | ..... | ..... | ..... | ..... | ..... |
| R & J Oil & Ref..... | Princeton, Ind. | Unifiner | 1,700 bbls. | ..... | Planning | ..... | ..... | ..... | ..... |
| | | Crude Unit | 5,000 bbls. | ..... | Under Constr. | Jan., 1959 | ..... | ..... | ..... |
| | | Platformer | 1,700 bbls. | ..... | Planning | ..... | ..... | ..... | ..... |
| Shell Oil..... | Wood River, Ill. | Exp. Lube Oil Plt. | 4,000 bbls. | ..... | Engineering | Mid 1959 | ..... | Lummus | Lummus |
| | | Offsite Facilities | ..... | $10,000,000 | Engineering | Mid 1960 | ..... | Parsons | Parsons |
| | Healdton, Okla. | Exp. Plant | ..... | $315,000 | Under Constr. | ..... | ..... | Staff | Hudson |
| Sinclair Refining... | East Chicago | M+K Deoiling | 1,000 bbls. | ..... | Complete | ..... | Texaco | Badger Mfg. | Badger Mfg |
| | | *Alkylation LPG Unit | ..... | ..... | Engineering | ..... | ..... | Braun | ..... |
| Skelly Oil Co..... | El Dorado, Kan | HF Alkylation | 3,000 to 4,000 bbls. | ..... | Engineering | ..... | Phillips | Staff | Staff |
| Socony Mobil..... | East St. Louis | Pretreater | 16,000 bbls. | ..... | Planning | ..... | ..... | Fluor | Fluor |
| Standard-Indiana... | Whiting, Ind. | Crude Distillation | 140,000 bbls. | ..... | Under Constr. | 1959 | ..... | McKee | McKee |
| | | Vacuum Distillation Tower | 36,000 bbls. | ..... | Under Constr. | 3rd Qtr., 1959 | ..... | Braun | ..... |
| | | Expand Cat Cracker | 10,000 bbls. | ..... | Engineering | 1960 | ..... | Kellogg | ..... |
| | Wood River, Ill. | Crude Unit | 67,500 bbls. | ..... | Under Constr | 1959 | ..... | McKee | McKee |
| | | Cat Cracker | 30,000 bbls. | ..... | Under Constr. | Early 1959 | ..... | McKee | McKee |
| | | Vacuum Distill Tower | 36,000 bbls. | ..... | Engineering | 1959 | ..... | ..... | ..... |
| | Mandan, N.D. | HF Alkylation Unit | 1,630 bbls. | ..... | Complete | ..... | Phillips | Foster Wheeler | Foster Wheeler |
| Sun Oil..... | Laverne, Okla. | *Gas Products Recovery Plt. | ..... | ..... | Under Constr. | July, 1959 | ..... | Pritchard | Pritchard |
| Texas Company..... | Lawrenceville, Ill. | Cat. Reformer | 12,000 bbls. | ..... | Engineering | 3rd Qtr., 1959 | ..... | Bechtel | Bechtel |
| | | Hydrotreater | 12,000 bbls. | ..... | Engineering | 3rd Qtr., 1959 | ..... | Bechtel | Bechtel |
| | Tulsa, Okla. | Alkylation | 2,050 bbls. | ..... | Engineering | 3rd Qtr., 1959 | ..... | ..... | ..... |
| | Camrick, Okla. | Gasoline Plant | ..... | $1,500,000 | Complete | ..... | ..... | Olsen | Olsen |
| Union Carbide.... | Marietta, Ohio | Liquid epoxy resin | 15,000,000 lbs./yr. | ..... | Under Constr. | 1959 | ..... | ..... | ..... |
| | Whiting, Ind. | *Low-density Polyethylene | 72,000,000 lbs/yr. | ..... | Under Constr. | Mid. 1959 | ..... | ..... | ..... |
| Warren Petroleum & Sunray | Forgan, Okla | Gasoline Plt. | 100 Mmcf | $3,000,000 | Engineering | ..... | ..... | ..... | ..... |
| Witco Chemical..... | Chicago | Phthalic Anhydride | 20,000,000 lbs./yr. | ..... | Under Constr. | Early 1959 | Scientific Design | Scientific Design | Scientific Design |
| **SOUTHWEST** | | | | | | | | | |
| American Cyanamid | Fortier, La. | Acrylonitrile | 100,000,000 lbs./yr. | $25,000,000 | Under Constr. | ..... | ..... | Chemico | Chemico |
| American Oil..... | Texas City | Heating Oil System | ..... | ..... | ..... | Complete | ..... | Tellepsen | Tellepsen |
| | | Two Stage Distill Unit | ..... | ..... | Under Constr. | ..... | ..... | Staff | Tellepsen |
| American Petrofina of Texas..... | Mt. Pleasant, Texas | Platformer | 3,000 bbls. | $800,000 | Under Constr. | ..... | UOP | Pritchard | Pritchard |
| | | Alkylation Plant | 1,400 bbls. | $1,000,000 | Under Constr. | ..... | UOP | Pritchard | Pritchard |
| Atlas Processing..... | Shreveport, La. | *Isomerization Unit | 3,900 bbls | ..... | Complete | ..... | UOP | UOP | Hudson |
| | | Deisopentanizer facilities | 4,700 bbls. | $3,100,000 | ..... | ..... | ..... | ..... | ..... |
| Calcasieu Chemical.. | Lake Charles | Ethylene Oxide; Ethylene Glycol | 8,000,000 gal./yr. | ..... | ..... | ..... | Shell | ..... | Lummus |
| Carbide & Carbon... | Seadrift, Texas | Ethylene Oxide Exp. | To 200,000,000 lbs./yr. | ..... | Planning | ..... | ..... | ..... | ..... |
| | | Inc. Ethylene Glycol Cap. | To 65,000,000 lbs./yr. | ..... | Planning | ..... | ..... | ..... | ..... |
| Chemoil Corp..... | New Orleans | Refinery | 40,000 bbls. | $35,000,000 | Planning | ..... | ..... | Lummus | Lummus |
| | Baton Rouge | Refinery | 40,000 bbls. | $35,000,000 | ..... | ..... | ..... | ..... | ..... |
| Cities Service..... | Lake Charles, La. | Inc. Reforming Cap. | ..... | ..... | Planning | ..... | ..... | ..... | ..... |
| Continental Carbon.. | Ponca City, Okla. | *Expansion, Carbon Black Plt. | 75,000,000 lbs/yr. | ..... | Under Constr. | Fall, 1959 | ..... | ..... | ..... |

* First appearance in tabulation. † Added capacity.

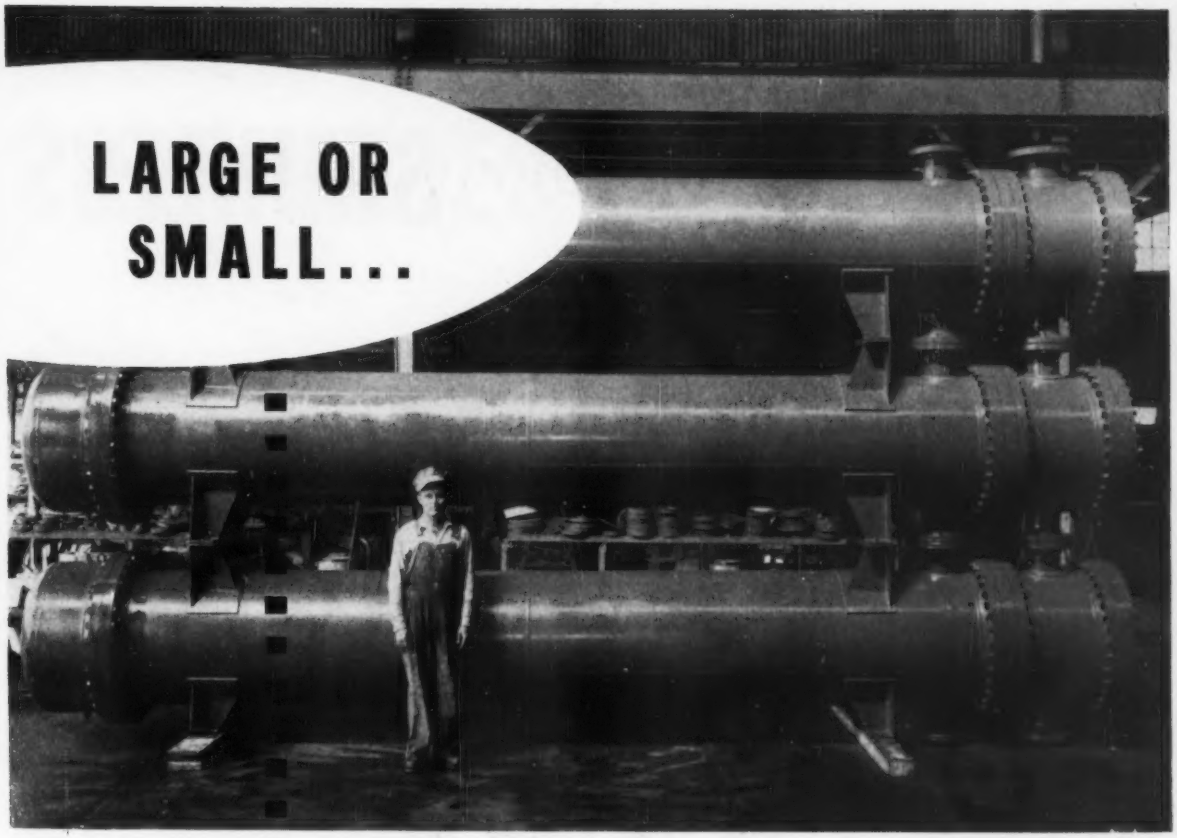
*Construction BOXSCORE Continued on Page 282*

## CONSTRUCTION BOXSCORE—*Continued*

| COMPANY | Plant Site | Project | Daily Capacity | Estimated Cost | Status | Probable Completion | Licensor | Engineering | Contractor |
|---|---|---|---|---|---|---|---|---|---|
| Copolymer Rubber & Chemical | Baton Rouge | Plt. Exp. Butadiene | 35,000 short tons yr. | ..... | Under Constr. | ..... | ..... | ..... | ..... |
| Diamond Alkali..... | Houston | Perchlorethylene Exp. | 50 percent | ..... | Under Constr. | ..... | ..... | ..... | ..... |
| | | Acetylene Plt. | ..... | ..... | Engineering | ..... | | | |
| | Deer Park | Vinyl Chloride Plt. | 50,000,000 lb./yr. | $10,000,000 | Complete | ..... | Scientific Design | Scientific Design | Brown & Root |
| | | Copolymer Unit | 25,000,000 lb/yr | ..... | Complete | ..... | ..... | Ferguson, Staff | Brown & Root |
| Dow Chemical..... | Plaquemine, La. | Ethylene and Propylene Glycols and Oxides, Chlorinated Solvents | ..... | $65,000,000 | Under Constr. | ..... | ..... | Bechtel; Sterns-Roger | Sterns-Roger; Tellepsen |
| | Freeport, Texas | *Chlorine, Ethylene Oxide | ..... | $30,000,000 | Under Constr. | 1959-60 | ..... | ..... | ..... |
| | | Acrylonitrile | | | | | | | |
| | | Polyethylene | | | | | | | |
| | | Polyglycol | ..... | $30,000,000 | Under Constr. | 1959-60 | ..... | ..... | ..... |
| D-X Sunray..... | Duncan, Okla. | *Cat Cracker Revamp | ..... | $600,000 | ..... | ..... | ..... | ..... | Treco |
| | | *Gas Turbine Blower | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| du Pont..... | Orange | Polyethylene | ..... | ..... | Under Constr. | ..... | ..... | ..... | ..... |
| | Beaumont | *Caprolactam | 50,000,000 lbs/yr. | ..... | Planning | Late, 1960 | ..... | Staff | Staff |
| | Near New Orleans | Petrochemical Plt. | ..... | ..... | Considering | ..... | ..... | ..... | ..... |
| El Paso Natural Gas | Odessa, Texas | Alkylation Blending | ..... | ..... | Under Constr. | ..... | ..... | ..... | ..... |
| | | Dehydration Plant | ..... | ..... | Under Constr. | ..... | ..... | Braun | Braun |
| | Crane, Texas | Expansion of Compressor and Treating Plant | ..... | $2,000,000 | Under Constr. | ..... | ..... | Olsen | Olsen |
| Goodrich-Gulf Chemicals | Port Neches, Texas | Exp. Synthetic Rubber Plant | ..... | $1,000,000 | Under Constr. | Feb., 1959 | ..... | Catalytic | Catalytic |
| Gulf Oil..... | Pt. Arthur, Texas | Greasemaking; Packaging | ..... | ..... | Under Constr. | ..... | ..... | Sumner Sollitt | Sumner Sollitt |
| | | Gasoline Processing | 10,000 bbls. | $4,000,000 | Under Constr. | ..... | UOP | Procon | Procon |
| | | Benzene Plt. | 82,000 gals | $6,800,000 | Under Constr. | Early 1959 | UOP | Procon | Procon |
| Humble..... | Baytown, Texas | Phenol Lube Plt. No. 2 | 31,500 bbls. | ..... | Under Constr. | 1959 | ..... | Kellogg, Brown & Root | Staff |
| | Rusk County, Texas | Remote Absorber | 80 Mmcf | ..... | Engineering | ..... | ..... | Staff | ..... |
| | Kleberg, County, Texas | Gas Process & Cycling Plt. | 800 Mmcf | ..... | Planning | 1960 | ..... | Staff | ..... |
| Jefferson Chemical.... | Port Neches, Texas | Inc. Ethylene Cap. | ..... | ..... | Under Constr | ..... | S&W | S&W | S&W |
| | | Inc. Ethylene Glycol Cap. | ..... | ..... | Complete | ..... | ..... | Braun | Braun |
| | | Inc. of Ethylene Oxide Cap. | ..... | ..... | Complete | ..... | Scientific Design | Scientific Design | Braun |
| | | *Ethanolamines | ..... | ..... | Under Constr. | Early, 1959 | ..... | Braun | Braun |
| Koppers Co..... | Port Arthur, Tex. | Exp. Polyethylene Plant | ..... | ..... | ..... | ..... | Staff | Staff | Staff |
| La Gloria Oil & Gas.. | Tyler, Texas | Gas Concentration; Revamp Cat Cracker | ..... | ..... | Under Constr. | ..... | UOP | UOP | Brown & Root |
| Magnolia..... | Beaumont, Texas | Crude Distill. | 100,000 bbls. | ..... | Under Constr. | Early, 1959 | ..... | Foster Wheeler | Foster Wheeler |
| | | *Cat. Desulfurization | 30,000 bbls. | ..... | Under Constr. | ..... | Socony Mobil | Staff, Foster Wheeler | Foster Wheeler |
| | | *Cat. Reforming | 20,000 bbls. | ..... | Under Constr. | Early, 1960 | ..... | Fluor | Fluor |
| | Cameron, La. | Gas Processing Plant | 120 Mmcf | ..... | ..... | Early 1959 | ..... | Dresser | Dresser |
| McBride Refining Co. | Port Brownsville, Texas | Ref. Expan. | †12,500 bbls. | $2,500,000 | Planned | ..... | ..... | ..... | ..... |
| Monsanto..... | Texas City | Exp. Acrylonitrile Plt. | 100,000,000 lbs./yr. | ..... | Under Constr. | ..... | ..... | ..... | ..... |
| | | Inc. Styrene Monomer Cap. | †40,000,000 lbs./yr. | ..... | ..... | ..... | ..... | ..... | ..... |
| Neches Butane Products | Port Neches, Texas | Butadiene Plt. Exp. | 300,000 tons/yr. | ..... | Under Constr. | Mar., 1959 | ..... | Foster Wheeler | Foster Wheeler |
| Pan American Petroleum | 18 miles north of Monahans, Tex. | Gas Processing Plant | 4 Mmcf | ..... | Complete | ..... | ..... | ..... | ..... |
| Petro-Tex..... | Houston | Sulfuric Acid Alkylation Plt. | 3,000 bbls. | ..... | Under Constr. | ..... | Texaco | Fluor | Fluor |
| | | Isobutylene Unit | 2,000,000 gal/yr | $250,000 | Under Constr. | ..... | ..... | ..... | ..... |
| Phillips Chemical..... | Sweeny, Trexas | Ethylene Plant† | ..... | ..... | Under Constr. | Spring, 1959 | ..... | Phillips | Phillips |
| Phillips Petroleum... | Sweeny, Texas | Hexane Isomerization | 1,000 bbls. | ..... | Under Constr. | 1959 | ..... | Phillips | Phillips |
| Runnels Gas Products & Texas Gas Expl. | Eunice, La. | *Gasoline Plt. Expansion | 69 Mmcf | $500,000 | Under Constr. | April, 1959 | ..... | ..... | Fluor |
| Shell Chemical..... | Norco | Cat. Gasoline Fractionator | ..... | ..... | ..... | ..... | Monsanto | Leonard Constr. Co. | Leonard Constr Co. |
| | | Platformer | 16,000 bbls. | ..... | Under Constr. | ..... | ..... | Procon | Procon |
| | | Acrolein Plant | 35,000,000 lbs./yr. | ..... | Under Constr. | ..... | ..... | ..... | ..... |
| | | Glycerine & Offsite Fac. | 35,000,000 lb/yr | $4,500,000 | Engineering | 1959 | ..... | Staff | Parsons; Fluor |
| | Houston | Phenol Plant | ..... | ..... | ..... | Late 1959 | ..... | ..... | Kellogg |
| Shell Oil..... | Weeks Island, La. | *Nat. Gas Processing | 120 Mmcf | ..... | Planning | ..... | ..... | ..... | ..... |
| Sinclair Refining..... | Houston | Udex Paraxylene | 50,000,000 lbs./yr. | $6,000,000 | Complete | ..... | UOP | Badger Mfg. | Badger Mfg. |
| | | Steam Generating & Water Treating | 250,000 lbs. hr. | $1,500,000 | Under Constr. | ..... | ..... | Kidde Engrs. | Kidde Const. |
| | Hulldale Field, Texas | Desulfuriser | ..... | ..... | Under Constr. | ..... | ..... | ..... | ..... |
| Spencer Chemical.... | Orange, Texas | Polyethylene Exp. | 90,000,000 lbs./yr. | ..... | Under Constr. | ..... | ..... | Staff | Quaker Valley |
| Texas Eastman..... | Longview, Tex. | Exp Polyethylene Plant | 85,000,000 lbs./yr. | ..... | Under Constr. | ..... | ..... | Girdler | Hudson |
| Texas Gulf Sulphur & Devon Palmer | Okotoks, Alberta | *Sulfur Recovery | 370 tons | $6,700,000 | Under Constr. | May, 1959 | ..... | Brown & Root | Brown & Root |
| | | *Gas Processing | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| Texas Natural Gasoline Corp. & Tennessee Gas Transmission | New Orleans | Natural Gasoline Plant | 150 Mmcfd | ..... | Under Constr. | ..... | ..... | ..... | Fluor |
| The Texas Co. | Port Arthur | Crude Unit | 86,000 bbls. | ..... | Under Constr. | ..... | ..... | Fluor | Fluor |
| | | Cat. Cracker | 60,000 bbls. | ..... | Under Constr. | ..... | ..... | Kellogg | Kellogg |
| | | Inc. Alkylation | 2,000 bbls.† | ..... | Under Constr. | ..... | ..... | Staff | Staff & Others |
| | | Cat. Reformer | 20,000 bbls. | ..... | Engineering | 2nd Qtr., 1959 | ..... | UOP | Staff & Fluor |
| | | Udex Unit | 28,000 bbls | ..... | Engineering | 2nd Qtr., 1959 | ..... | UOP | Staff & Fluor |
| | El Paso | Alkylation | 1,600 bbls. | ..... | Engineering | 3rd Qtr., 1959 | ..... | Texas Co. | ..... |
| Union Carbide..... | Seadrift, Texas | *Ester & Alcohol Plts. | 100,000,000 lbs/yr. | ..... | Design | 1960 | ..... | ..... | ..... |
| United Rubber & Chemical | Baytown, Texas | Synthetic Rubber Facil. | ..... | ..... | Under Constr. | ..... | ..... | Day & Zimmerman | Tellepsen |

* First appearance in tabulation. † Added capacity.

*Construction BOXSCORE Continued on Page 287*



# LARGE OR SMALL...

## EFCO does it right

One reason that Efco does it *right* is its many years of experience in designing and fabricating heat-exchangers for the wide range of temperatures and pressures represented by ethylene plants and platinum catalyst reforming units. We are recognized specialists in handling all grades of carbon, alloy, and stainless steels, nickel, aluminum, and special low-temperature materials.

***EFCO'S FOUR POINT PROGRAM PROVIDES:***

**service-proved engineering design**
**guaranteed job-ratings**
**complete fabricating facilities**
**technical service before, during and after installation**

***ASK OUR GULF COAST CUSTOMERS – THEY KNOW US WELL***

**Write for General Catalog**

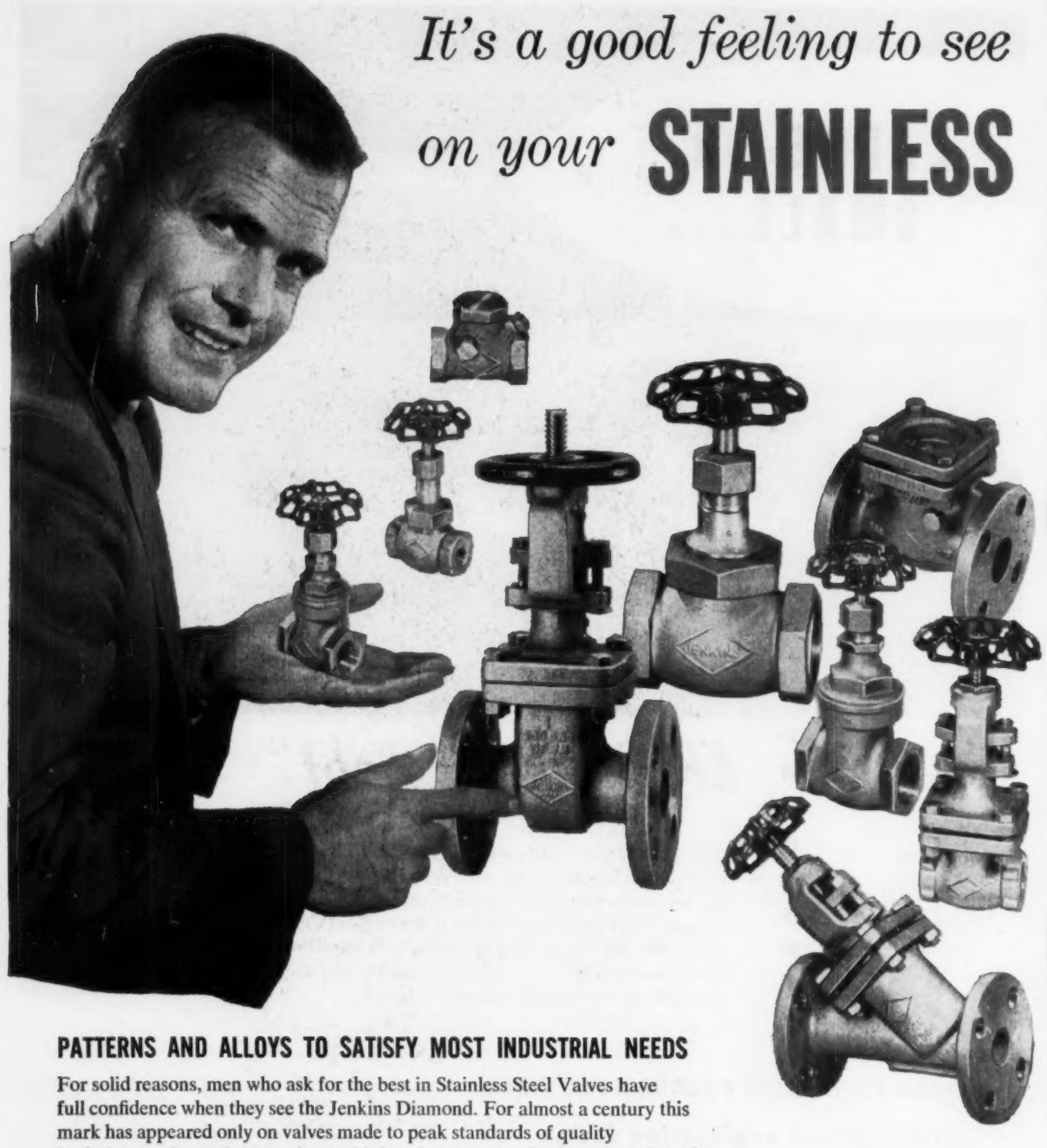
**EFCO HEAT TRANSFER EQUIPMENT**
*Engineers and Fabricators, Inc.*
**P. O. BOX 7395** **HOUSTON 8, TEXAS**

EFCO


For more data on advertised products, use Readers' Service Cards, last page.

*It's a good feeling to see*

*on your* **STAINLESS**



**PATTERNS AND ALLOYS TO SATISFY MOST INDUSTRIAL NEEDS**

For solid reasons, men who ask for the best in Stainless Steel Valves have full confidence when they see the Jenkins Diamond. For almost a century this mark has appeared only on valves made to peak standards of quality in design . . . in castings . . . in machining. JENKINS standards, enforced by the most rigid inspection and testing in the valve industry.

Valves of corrosion resistant stainless steels have been made to those high standards by Jenkins for a quarter of a century. And today, the line of Jenkins Stainless Steel valves includes types and alloys to fully satisfy most service requirements.

They are available through the same leading distributors everywhere who sell Jenkins Valves of Bronze, Iron and Cast Steel.

JENKINS VALVES JENKINS SINCE 1864.

*this trusted mark*

# STEEL VALVES *too*

JENKINS BROS., 100 Park Avenue, New York 17, N. Y.

☐ Send the new stainless steel valve catalog

☐ Have a representative call on me

NAME & TITLE.....

COMPANY.....

ADDRESS.....



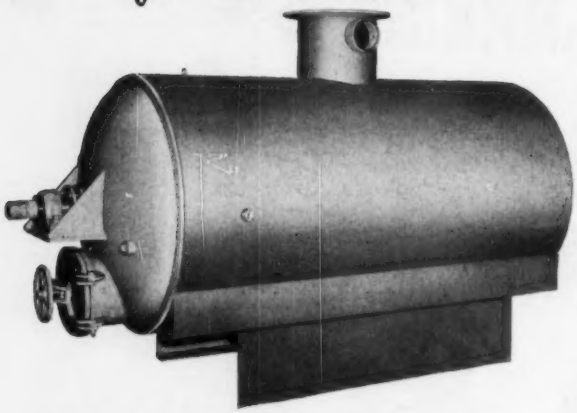
For more data on advertised products, use Readers' Service Cards, last page.

# FELKER BROS. MFG. COMPANY

*Metal Fabricators for OVER 50 YEARS*

MARSHFIELD, WISCONSIN
Phones — 230 and 231

## FELKERWELD for Endurance



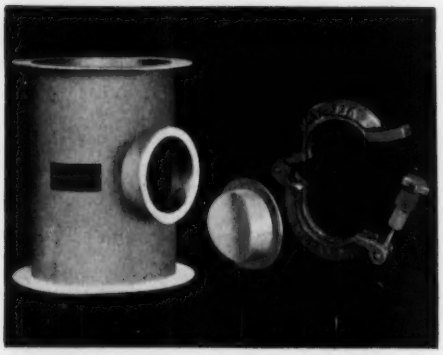
• A Pressure Cooker of open hearth mild steel fabricated to customer specifications.

Our more than 50 years' experience in fabricating plain steel, applied to stainless steel when it came into the market enabled us to develop our FELKERWELD PROCESS for ENDURANCE, with such metals as Stainless Steel, Stainless Clad Steel, Inconel, Monel, Nickel, Copper and Aluminum Bronze. FELKERWELD is your guarantee for quality workmanship.

## ASME Code

Our shop is qualified for construction under the A S M E Code for unfired pressure vessels, to current code requirements.

## We Fabricate to Your SPECIFICATIONS



• FELKERWELD plug type CLEAN OUTS with quick opening Vee Grip Flange.

We invite inquiries on any Fabricated Products . . . write, phone or wire . . . estimates promptly furnished. Ask for our Bulletin No. 505.

• FREEFLOW Type Stainless Steel Elbows —Fittings available in all metals.

**FELKER BROTHERS MANUFACTURING CO.**
PHONES 230-231 MARSHFIELD, WIS.

## CONSTRUCTION BOXSCORE—*Continued*

| COMPANY | Plant Site | Project | Daily Capacity | Estimated Cost | Status | Probable Completion | Licensor | Engineering | Contractor |
|---|---|---|---|---|---|---|---|---|---|
| U. S. I. Chem. Corp... | Houston | Polyethylene Plant | 75,000,000 lbs./yr. | $20,000,000 | Under Constr. | Early 1959 | I.C.I. | Kellogg | Kellogg; Tellepsen |
| **ROCKY MOUNTAIN** | | | | | | | | | |
| Carter Oil Co..... | Billings, Mont. | Increase Crude Cap. | 34,500 bbls. | $1,500,000 | Under Constr. | ..... | ..... | Esso | Staff |
| Pan American..... | Riverton, Wyoming | Gasoline Plant | ..... | $1,000,000 | Under Constr. | April, 1959 | ..... | Olsen | Olsen |
| Southwestern Agro-chemical Corp. | Chandler, Ariz. | Ammonia Synthesis Plt. and related facilities | 60 tons | $5,000,000 | Planning | June, 1959 | ..... | ..... | ..... |
| The Texas Co..... | San Juan County, Utah | Gasoline Plt. | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| **WEST COAST** | | | | | | | | | |
| California Ammonia Co. | Lathrop, Calif. | Ammonia Synthesis Plt. | 100 tons | $5,000,000 | Engineering | 1959 | ..... | Macco | Macco |
| du Pont..... | Antioch, Calif. | Fluorinated Hydrocarbons, Tetraethyl Lead | ..... | ..... | Under Constr. | ..... | ..... | ..... | ..... |
| Fletcher Oil..... | Wilmington, California | Unifiner Platformer | ..... | ..... | Under Constr. | ..... | UOP | Parsons | Parsons |
| Hancock Oil..... | Long Beach, Calif. | Rebuild Refinery | ..... | ..... | Planning | 1960 | ..... | Nofsinger | Nofsinger |
| Vally Nitrogen..... | California | *Ammonia Plt. | 150 tons | ..... | Engineering | 1959 | Chemico | Chemico | Chemico |
| Richfield Oil..... | Los Angeles | Benzene Plt. | 18,000,000 gal./yr. | ..... | Under Constr. | ..... | ..... | ..... | ..... |
| Shell Chemical..... | Watson, Calif. | Crude Topping Unit | 37,000 bbls. | $4,000,000 | Under Constr. | 1st Qtr. 1959 | ..... | Parsons; Staff | Parsons |
| | Dominguez, Calif. | Exp. Isopropyl Alcohol Facl. | ..... | ..... | Under Constr. | ..... | ..... | ..... | ..... |
| Shell Development Co. | Emeryville Calif. | Research Lab. | ..... | $500,000 | Under Constr. | ..... | ..... | ..... | ..... |
| Shell Oil..... | Wilmington | Boiler for Cat. Cracker | 200,000 lbs. | $1,000,000 | Under Constr. | ..... | ..... | ..... | ..... |
| Standard Oil (Calif.).. | Richmond | FCC Unit | 40,000 bbls. | ..... | Under Constr. | July, 1959 | ..... | Fluor | Fluor |
| | El Segundo | Steam Generating Plant | 275,000 lbs./hr. | $2,000,000 | Engineering | July, 1959 | ..... | Fluor | Fluor |
| The Texas Co..... | Anacortes, Wash. | Refinery<br>Fluid Cat Cracker<br>Alkylation<br>Reforming<br>Polymerization<br>Hydrotreating | 40,000 bbls. | ..... | Under Constr. | 1st Qtr, 1959 | ..... | Bechtel | Bechtel |
| | Los Angeles | Udex Unit | 9,000 bbls. | ..... | Under Constr. | 2nd Qtr. 1959 | ..... | UOP | ..... |
| Tidewater..... | Avon, Calif. | Steam Generating Plt. | 50,000 lbs./hr. | ..... | Complete | ..... | ..... | Bechtel | Bechtel |
| **OUTSIDE U.S.A.** | | | | | | | | | |
| **Hawaii** | | | | | | | | | |
| Standard Oil (Calif.).. | Honolulu | Refinery | 35,000 bbls. | $40,000,000 | Engineering | 1961 | ..... | Staff, Bechtel | Bechtel, Hawaiian Dredging |
| **Canada** | | | | | | | | | |
| British American Oil.. | Clarkson, Ont. | Distillate Desulfurizer | 8,000 bbls. | $2,200,000 | Under Constr. | Early, 1960 | ..... | Kellogg | Kellogg |
| | | *Compounding, Blending & Grease Plt. | ..... | ..... | Engineering | ..... | ..... | Nofsinger | ..... |
| | Nevis, Alberta | Gasoline Plt. | 15 Mmcf | *$7,000,000 | Complete | ..... | ..... | Mannix | Mannix |
| | Pincher Creek | Sulfur Recovery | 225 tons | $25,000,000 | Complete | ..... | ..... | Parsons | Parsons |
| | | Gas Processing | 2,200 bbls. | ..... | ..... | ..... | ..... | ..... | ..... |
| | Port Moody | Refinery | 20,000 bbls. | $25,000,000 | Complete | ..... | ..... | Kellogg | Kellogg |
| | Moose Jaw, Sask. | Cat Reformer & HDS Unit | 5,400 bbls. | $3,900,000 | Under Constr. | ..... | Atlantic | Lummus, Procon | Lummus, Procon |
| | | Gas Splitter | ..... | ..... | Engineering | ..... | UOP | UOP Procon | Procon |
| | | | 7,000 bbls. | $4,000,000 | Under Constr. | ..... | ..... | Procon | Procon |
| | Montreal | Gaso. Splitters | 12,000 bbls. | $750,000 | Complete | ..... | ..... | Procon | Procon |
| British Petroleum.... | Ville D'Anjou Near Montreal | Refinery | 25,000 bbls. | $30,000,000 | Under Constr. | Mid 1960 | ..... | ..... | Lummus |
| | | *Cat Cracker | 9,000 bbls. | ..... | ..... | ..... | ..... | ..... | ..... |
| | | *Platformer | 6,000 bbls. | ..... | ..... | ..... | ..... | ..... | ..... |
| | | *Cat Hydrogenation | 12,000 bbls. | ..... | ..... | ..... | ..... | ..... | ..... |
| | | *Cat Polymerization | 700 bbls. | ..... | Under Constr. | ..... | ..... | ..... | ..... |
| Canadian Husky Oil.. | Ft. William | Dieulformer & Tankage | 1,000 bbls. | $700,000 | Complete | ..... | Husky | ..... | Poole-Pritchard |
| Canadian Oil Co., Ltd. | Corunna, Ontario | Platformer Exp. | 6,000 bbls. | ..... | Under Constr. | ..... | UOP | UOP | Catalytic |
| | | Crude Unit | 20,000 bbls. | $3,000,000 | Engineering | 1959 | ..... | Kellogg | Kellogg |
| Canadian Petrofina... | Montreal | Increase Cap. | 30,000 bbls. | $3,000,000 | Under Constr. | ..... | ..... | Staff | Procon (Canada) |
| Cities Service..... | Toronto | New Refinery | 20,000 bbls. | $36,000,000 | Complete | ..... | ..... | Braun, Ltd. | Braun, Ltd. |
| Consumers, Cooperative Refinery, Ltd. | Regina, Sask. | Coking Unit | 3,000 bbls. | $1,900,000 | Complete | ..... | ..... | UOP; Staff | Fluor; Staff |
| Canadian Industries, Ltd. | Edmonton, Alberta | Inc. Polythene | 40,000,000 lbs./yr. | ..... | Under Constr. | 1959 | ..... | ..... | Poole Constr. Co., Ltd. |
| Cyanamid of Canada. | Hamilton, Ontario | Urea; Ammonia | ..... | ..... | Engineering | 1959 | ..... | Chemico | Chemico |
| Devon-Palmer & Texas Gulf Sulfur | Calgary, Alberta | Sulfur Extraction Plant | 400 tons | $8,000,000 | Planning | Mid 1959 | ..... | ..... | ..... |
| Excelsior Refineries... | The Pas, Manitoba | Refinery | 2-3,000 bbls. | $1,500,000 | Planning | ..... | ..... | ..... | ..... |
| Imperial Oil..... | Sarnia | Refinery Exp. | 94,000 bbls. | $5,360,000 | Under Constr. | Summer, 1959 | ..... | Staff | Staff |
| | Edmonton, Alberta | Asphalt Plant & Storage | 1,500 bbls. | $1,100,000 | Under Constr. | Feb., 1959 | ..... | Staff, Foster Wheeler | Foster Wheeler |
| | Calgary | Crude Cap. | 14,700 bbls. | | | | | | |
| | | Cat. Cracker | 6,600 bbls. | $17,000,000 | Under Constr. | Summer 1959 | ..... | Canadian Bechtel; Staff | Canadian Bechtel |
| | | Powerformer | 2,700 bbls. | | | | | | |
| | | Offsite Facilities | | | | | | | |
| | Regina | Powerformer | 3,000 bbls. | ..... | Under Constr. | September, 1959 | ..... | Staff | Canadian Kellogg |
| | Winnipeg | *Alkylation Unit | 650 bbls. | $2,600,000 | ..... | ..... | ..... | ..... | ..... |
| Irving Refining..... | St. John, New Brunswick | Hydrogen Plant | ..... | ..... | Engineering | 1960 | ..... | Girdler Bechtel | Canadian Bechtel |
| North Star Oil, Ltd... | St. Boniface, Manitoba | Platformer Unifiner | 2,700 bbls. | $1,500,000 | Complete | ..... | UOP | UOP Procon | Procon |
| Shell Oil (Canada).... | Bronte, Ont. | Refinery | ..... | ..... | Considering | ..... | ..... | ..... | ..... |
| | Montreal | HF Alkylation | 1,500 bbls. | $4,000,000 | Complete | ..... | UOP | UOP<br>Treco, Staff | Treco |
| | Vancouver | Solvent Plt. | ..... | $600,000 | Under Constr. | ..... | ..... | Fluor, Staff | Staff |
| Steelman Gas, Ltd.... | Southeast Saskatchewan | Natural Gas Plant | 25 Mmcf | $6,500,000 | Under Constr. | ..... | ..... | Stearns-Roger, Engineering Co. Ltd. | Treco, Ltd. |
| Westcoast Transmission | Coleman, Alberta | Gas Processing Plt. | ..... | $15,000,000 | Planning | ..... | ..... | ..... | ..... |

* First appearance in tabulation. † Added capacity.

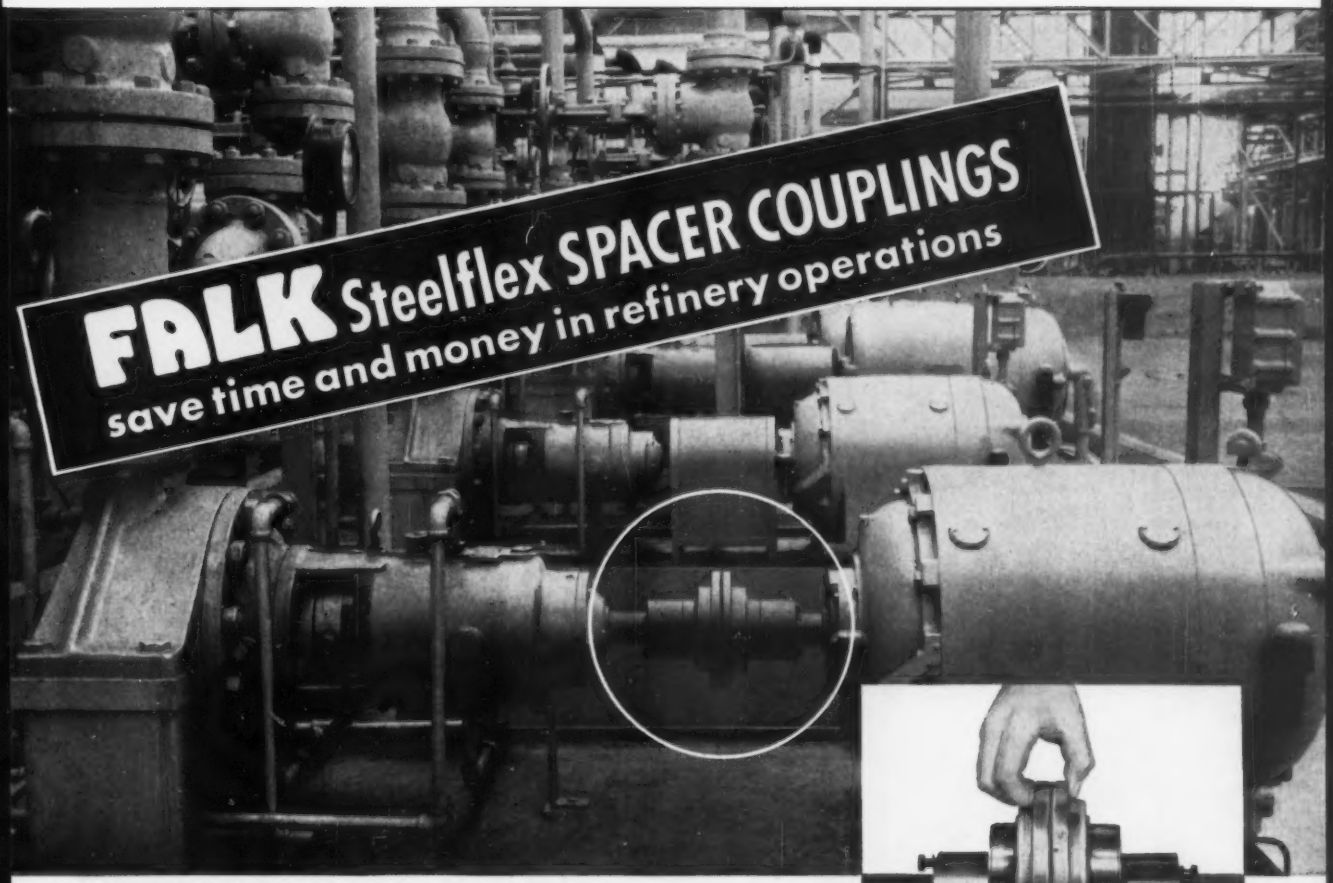
*Construction BOXSCORE Continued on Page 288*

## CONSTRUCTION BOXSCORE—*Continued*

| COMPANY | Plant Site | Project | Daily Capacity | Estimated Cost | Status | Probable Completion | Licensor | Engineering | Contractor |
|---|---|---|---|---|---|---|---|---|---|
| **LATIN AMERICA** | | | | | | | | | |
| **Argentina** | | | | | | | | | |
| Argentine Government | Santa Fe Province | *Naphtha Reforming Plt. | ..... | ..... | Planning | ..... | ..... | ..... | ..... |
| Carbometal | Mendoza | *Polyvinyl Choride | 4,500 tons/yr. | ..... | ..... | ..... | ..... | ..... | ..... |
| | | *Acetylene | 200 tons/yr. | ..... | ..... | ..... | ..... | ..... | ..... |
| | | *Plastics | 7,500 tons/yr. | ..... | Planning | ..... | Monsanto | Monsanto | Monsanto |
| **Brasil** | | | | | | | | | |
| Alba (Borden) | Cubatao | Methanol, Formaldehyde, Synthetic Resins | 30 tons | $4,600,000 | Under Constr. | ..... | Vulcan Texaco Fischer | Vulcan Girdler | Staff Girdler Austin; Montreal, S.A |
| Anglo-Ecuadorian Oilfields, Ltd. | La Libertad Ecuador | Atmospheric Distillation Plant | 7,000 bbls. | $4,500,000 | Under Constr. | ..... | UOP | Procon | Procon |
| Empresa Colombiana de Petroleos | El Centro | Nat. Gasoline Plant | 51.4 Mmcf | $2,700,000 | Under Constr. | October, 1959 | ..... | Parsons | Parsons |
| North American Solvay, Inc. | Sao Paulo | Ethylene Purification | 20 tons | ..... | Under Constr. | 1st quarter 1959 | ..... | Hydrocarbon | Hydrocarbon/ SETAL |
| Petroleo Brasileiro | Mataripe | Atmospheric & Vacuum Distill. Units, Cat. Crkr., Gas Recovery, Wax Treating, Lube Plt. | 37,000 bbls. | ..... | Under Constr. | 1960 | Kellogg | Kellogg | Kellogg Brasileira; Montreal, S. A. |
| | Rio de Janeiro South Brasil | New Refinery | 90,000 bbls. | $60,000,000 | Engineering | Early 1960 | ..... | Foster Wheeler | ..... |
| | | Refinery | 70,000 bbls. | ..... | Planning | ..... | ..... | ..... | ..... |
| Ubde | Cubatao | Urea Plt. | ..... | ..... | ..... | ..... | ..... | Ubde | Ubde |
| Union Carbide | Cubatao | Polyethylene | ..... | ..... | Under Constr. | ..... | ..... | Brown & Root | Brown & Root Ltd. |
| **Colombia** | | | | | | | | | |
| Empresso Colombiana de Petroleos | Barranca Bermeja | Exp. Propane Recovery | 1,000 bbls. | $1,000,000 | Planning | ..... | ..... | ..... | ..... |
| **Chile** | | | | | | | | | |
| Empresa Nacional del Petroleo | Concon | Refinery Exp: | | | | | | | |
| | | Crude Topping | 24,000 bbls. | | | | | | |
| | | Vacuum Unit | 10,000 bbls | | | | | | |
| | | Orthoflow FCC Unit | 12,000 bbls. | $15,000,000 | Under Constr. | Oct., 1959 | Kellogg | Kellogg | Staff & Kellogg |
| | | SBK Cat. Reforming and Desulfurization | 6,000 bbls. | | | | | | |
| | | Alkylation Unit | 1,100 bbls. | | | | | | |
| **Ecuador** | | | | | | | | | |
| Anglo-Ecuadorian Oilfields, Ltd. | Santa Elena Ancon | Atmospheric Distillation | ..... | ..... | Under Constr. | ..... | UOP | Procon | Procon |
| | | Thermal Cracking Units | ..... | ..... | Under Constr. | ..... | UOP | Procon | Procon |
| **Mexico** | | | | | | | | | |
| Pemex | Ascapotzalco | *Refinery | 20,000 bbls. | $20,000,000 | ..... | ..... | ..... | ..... | ..... |
| | Ciudad Madero | Topping | 100,000 bbls. | | | | | | |
| | | Cat. Cracking | 25,000 bbls. | | | | | | |
| | | Gas Concentration; HF Alkylation; Polymerization; Sulfur Plt. | | $25,700,000 | Under Constr. | Late 1959 | Phillips, Esso, UOP | McKee | Staff |
| | Salamanca | Grease Plt. | 25 tons | $1,700,000 | Engineering | ..... | ..... | McKee | Staff |
| | | Cat. Cracker | 15,000 bbls. | ..... | Planning | ..... | ..... | ..... | ..... |
| | Posa Rica | Topping Plt. | 10,000 bbls. | $1,350,000 | Engineering | ..... | ..... | Staff | Staff |
| **Netherlands Antilles** | | | | | | | | | |
| Largo Oil & Transport | Aruba, N. A. | Revamp Distillation & Visbreaking Units | ..... | ..... | Engineering | Nov., 1959 | ..... | Kellogg | Kellogg |
| **Panama** | | | | | | | | | |
| Refiner a Petroquimica de Panama | Portobelo | *Refinery | 55,000 bbls. | $40,000,000 | Engineering | 1961 | ..... | Foster Wheeler | Foster Wheeler |
| Refineria Panama | Las Minas Bay, Coson | Refinery; Petrochemicals | 70,000 bbls. | $59,000,000 | Under Constr. | 1959 | ..... | Pet. Comb. & Eng. Co. | Pet. Comb. & Eng. Co. |
| **Paraguay** | | | | | | | | | |
| Compagnie Fives-Lille | Asuncion, Paraguay | Refinery | 10,000 bbls. | ..... | Planning | ..... | ..... | ..... | ..... |
| **Puerto Rico** | | | | | | | | | |
| Commonwealth Oil Refining | Guayanilla Bay | *Visbreaker | 20,000 bbls. | $2,700,000 | Under Constr. | Early, 1959 | ..... | Lummus | Lummus |
| | | *Unifiner | 6,500 bbls. | $1,200,000 | Under Constr. | Early, 1959 | UOP | Howe-Baker | Procon |
| | | *Gasoline | 2,000 bbls. | ..... | Under Constr. | Early, 1959 | Howe-Baker | Howe-Baker | Procon |
| | | *Ref. Modifications | 75,000 bbls. | $6,300,000 | Under Constr. | Early, 1959 | ..... | UOP | Procon-Other |
| Union Carbide Caribe | Ponce | Ethylene-Glycol | 500,000 lbs. | $28,500,000 | Planning | Early 1959 | ..... | Brown & Root | Brown & Root |
| **Trinidad** | | | | | | | | | |
| Federation Chemicals, Ltd. | Point Lisas | Nitrogen Plant | 100 tons | $12,000,000 | Under Constr. | Fall, 1959 | Kellogg | Braun & Kellogg | Braun |
| | | Urea | 70 tons | ..... | ..... | ..... | Monsanto, | ..... | ..... |
| | | Ammonia | 100 tons | ..... | ..... | ..... | Stamicarbon | ..... | ..... |
| | | Sulfuric Acid | 200 tons | ..... | ..... | ..... | ..... | ..... | ..... |
| | | Ammonium Sulfate | 245 tons | ..... | Under Constr. | 1959 | ..... | Braun-Kellogg | Braun-Kellogg |
| Trinidad Oil Co., Ltd. | Pointe-a-Prierre | Processing Units | ..... | ..... | Under Constr. | ..... | UOP | Procon | Procon |
| **Uruguay** | | | | | | | | | |
| Administracion Nacional de Combustibles Alcohol Y Portland | Montevideo | Crude Distill. | 28,000 bbls. | $12,000,000 | Engineering | Late 1959 | ..... | | |
| | | Vac. Distill. | 10,000 bbls. | ..... | ..... | ..... | ..... | | |
| | | Cat. Cracker | 5,000 bbls. | ..... | ..... | ..... | ..... | | |
| | | Cat. Reformer | 3,000 bbls. | ..... | ..... | ..... | ..... | | |
| | | Gas Concent. & Bottling | ..... | ..... | ..... | ..... | ..... | Kellog | Staff |
| | | Gas Sweetening | 4,500 bbls. | ..... | ..... | ..... | ..... | | |
| | | Sulfur Recovery | 8 tons | ..... | ..... | ..... | ..... | | |
| | | Power Plt. & Offsite Facil. | 3,600 KW | ..... | ..... | ..... | ..... | | |
| **Venezuela** | | | | | | | | | |
| Cia Shell de Venezuela | Cardon | Distillation | 80,000 bbls. | $20,000,000 | Under Constr. | ..... | ..... | ..... | ..... |
| | | Alkylation | 2,800 bbls. | ..... | Under Constr. | ..... | ..... | ..... | ..... |
| Compania Shell de Venezuela | La Paz, Maracaibo | Extension to Paz Compressor Plt. | ..... | ..... | Under Constr. | May, 1959 | ..... | Lummus | Lummus |
| Creole Pet. Corp. | Amuay Bay | Naphtha Fractionator | 45,000 bbls. | ..... | Engineering | 1959 | ..... | Esso | ..... |
| Socony Mobil | El Palito | Refinery | 40,000 bbls. | $28,000,000 | Under Constr. | Late 1959 | ..... | Kellogg | Kellogg |
| Venezuela Gulf Refg. | Puerto la Cruz | Crude Distillation | 65,000 bbls. | ..... | Engineering & Constr. | Late 1959 | ..... | Foster Wheeler | Foster Wheeler |
| **EUROPE AND AFRICA** | | | | | | | | | |
| **Austria** | | | | | | | | | |
| Austrian Oil Administration | Schwechat near Vienna | Crude Unit, Cat Reformer Gas Recovery & Chemical Units | 35,000 bbls. 7,000 bbls. | $22,300,000 | Engineering | End 1959 | ..... | Lurgi | Lurgi |
| Danubia Petrochemie A.G. | Schwechat near Vienna | *Polypropylene Plt. | 11,000,000 lbs/ yr. | ..... | ..... | ..... | ..... | ..... | ..... |
| **Canary Islands** | | | | | | | | | |
| Cepsa | Las Palmas | Ammonia | 90 tons | ..... | Engineering | ..... | Hoechst | Ubde | Ubde |

* First appearance in tabulation. † Added capacity.

*Construction BOXSCORE Continued on Page 291*

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## Cut disconnect-reconnect time by as much as 50%

The FALK Spacer Coupling is specially designed for quick installation or removal *without disturbing the driving or driven unit*. This feature can save you up to 50% in disconnect-reconnect time when critical equipment—a process pump, for example—needs repair or replacement.

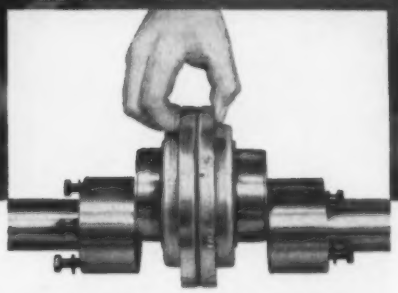
Here's another saving: with the FALK Spacer Coupling, you can quickly realign shafts *without the usual loss of operating temperature!*

And still another: you can remove or reinstall the FALK Spacer as a unit *without draining the lubricant.*

Because of its exclusive grid-groove Steelflex design, the FALK Spacer can accommodate residual misalignment—parallel, angular, or (most important) *both.* Also, it provides torsional resiliency that cushions shock and vibration. Thus it saves wear-and-tear on your connected equipment.

To prove these claims and enjoy these savings, install a FALK Spacer on one application—and see for yourself. Consult your FALK Representative or Authorized Distributor.

**THE FALK CORPORATION, MILWAUKEE 1, WISCONSIN**
*MANUFACTURERS OF QUALITY GEAR DRIVES AND FLEXIBLE SHAFT COUPLINGS*
**Representatives and Distributors in many principal cities.**

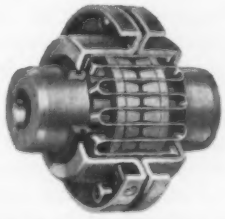


### EASY AND QUICK TO INSTALL, DISCONNECT OR RECONNECT

First, mount shaft hubs to allow proper distance between hubs; then, align driving and driven units.

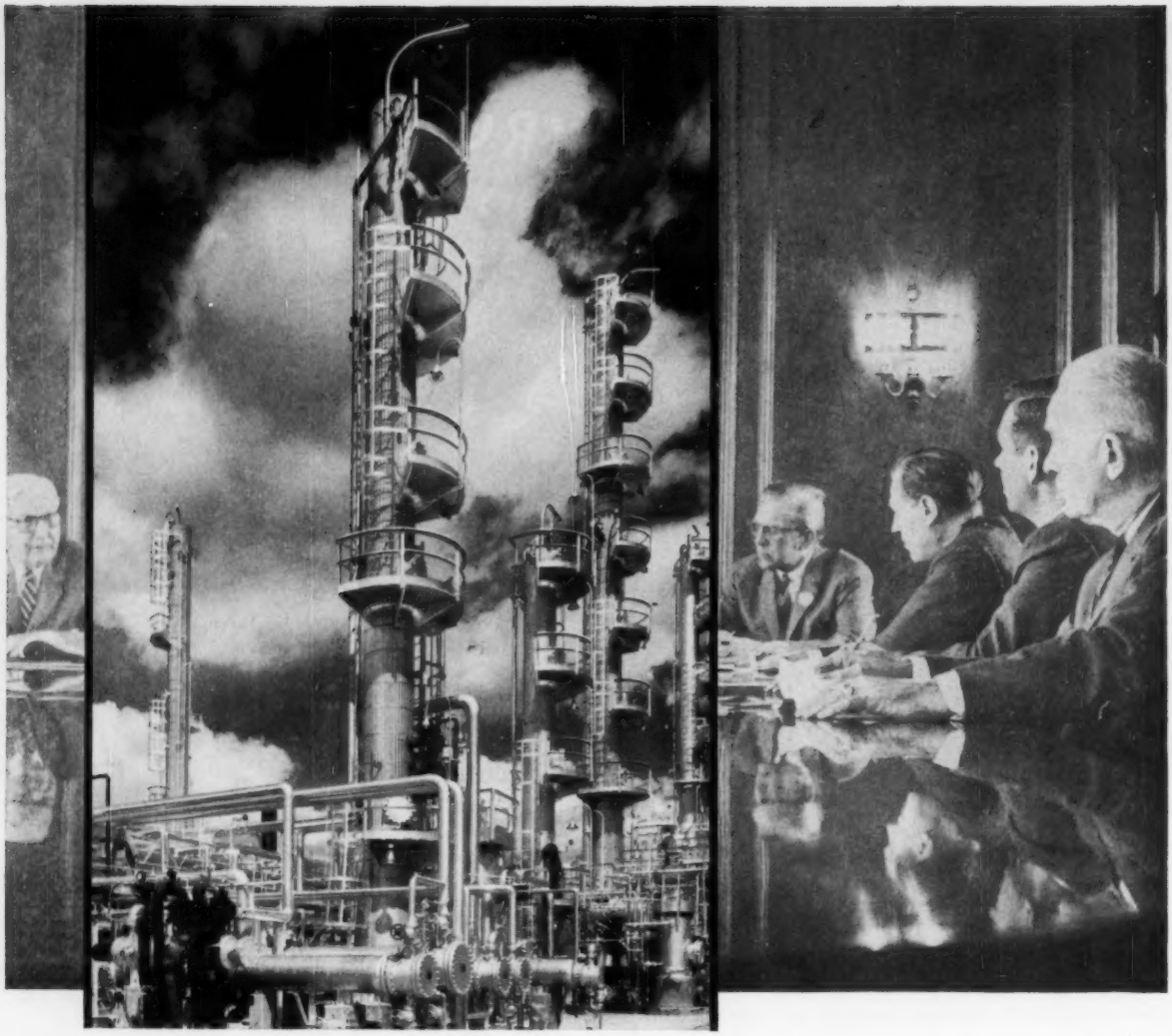
Second, compress Spacer to fit space between hubs and tighten cap screws to pull spacer hubs into the registered fit.

To disconnect, reverse the second step. No draining of lubricant necessary.



**The heart of the FALK Spacer ...the basic Type F Steelflex**
*Write for Service Manual 4838*

**FALK**
...a good name in industry



# *Pritchard applies automatic data logging with, above all, GOOD FINANCIAL DESIGN*

Socony's new 6000 bbl/day catalytic reforming unit at Casper, Wyoming might have been just another refinery addition–except for one vital difference. Along with the usual vessels and piping, J. F. Pritchard & Co., engineers and builders of the unit, provided a complete data logging and scanning system to monitor processes. This centralized automatic system supplements manual supervision and contributes to more efficient operation. The end result is lower operating costs and more profitable refinery operation.

The construction of this ultra-modern refining unit is an example of how Pritchard looks beyond the obvious to engineer and build plants with good financial design – the "extra" that gives Pritchard clients maximum return on capital.

Pritchard's experience in petroleum ranges from the design, engineering and construction of individual processing units to complete refineries. Pritchard also serves the oil field processing industry with facilities for operations such as sulphur removal and recovery, natural gas dehydration and pressure maintenance. If you are considering new construction in these fields, ask Pritchard to show you how good financial design can work for you.

PROFITABLE FACILITIES THROUGH GOOD FINANCIAL DESIGN

J.F. Pritchard & Co.

ENGINEERS • CONSTRUCTORS

Dept. 406, 4825 Roanoke Parkway, Kansas City 12, Mo.

OFFICES IN CHICAGO, HOUSTON, PITTSBURGH, NEW YORK

SERVING THE GAS, POWER, PETROLEUM AND CHEMICAL INDUSTRIES



For more data on advertised products, use Readers' Service Cards, last page.

## CONSTRUCTION BOXSCORE—*Continued*

| COMPANY | Plant Site | Project | Daily Capacity | Estimated Cost | Status | Probable Completion | Licensor | Engineering | Contractor |
|---|---|---|---|---|---|---|---|---|---|
| **England** | | | | | | | | | |
| British Hydrocarbon Chemicals | Grangemouth | *Ethylene Plt. | 70,000 tons/yr. | ..... | Under Constr. | Mid 1960 | ..... | ..... | ..... |
| British Petroleum.... | Kent | Hydrofiner II | 10,000 bbls. | ..... | Under Constr. | ..... | ..... | Kellogg | McAlpine, Wimpey |
| | | Udex Unit | 500 bbls. | ..... | Under Constr. | ..... | ..... | UOP, Badger | McAlpine, Wimpey |
| Eastern Gas Board... | Ponders End. | Catalytic Oil Gasification | 7.4 Mmcf | ..... | Complete | ..... | ..... | Power-Gas | Power-Gas |
| Esso Petroleum..... | Fawley | Steam Cracker<br>Butene Dehydrogenation Plant<br>Ethylene Recovery Plant<br>Butadiene Extraction Plant | 40,000 lt. tons/yr | $27,000,000 | Under Constr. | ..... | ..... | Foster Wheeler | Foster Wheeler |
| | | Powerformer | 21,000 bbls. | $12,000,000 | Under Constr. | Early 1959 | ..... | Lummus | Lummus |
| | | Sulfur Plant | 60 tons | $700,000 | Under Constr. | ..... | ..... | Foster Wheeler | Foster Wheeler |
| | Milford Haven | Refinery | 100,000 bbls. | $52,000,000 | Planning | Early 1960 | ..... | ..... | ..... |
| International Synthetic Rubber | Fawley | Synthetic Rubber | 70,000 tons/yr. | $15,000,000 | Complete | ..... | ..... | Blaw Knox | Blaw Knox |
| Malta Gas Board..... | Valetta | Catalytic Oil Gasification | 1 Mmcfd | ..... | Under Constr. | Early 1959 | ..... | Power-Gas | Power-Gas |
| Mobil Oil Co., Ltd.... | Coryton | Cat. Hydrodesulfurisation | ..... | ..... | Pre-engineering | ..... | ..... | ..... | ..... |
| | | Crude Unit Exp. | 5,000 bbls. | ..... | Under Constr. | ..... | ..... | Staff | Staff |
| North Thames Gas Board | Romford | Refinery Tail Gas Reforming | 36 Mmcf | ..... | Under Constr. | ..... | ..... | H & G | H & G |
| North Western Gas Board | Manchester Partington | Pressure Oil Gasification | 7.5 Mmscf | ..... | Engineering | Dec., 1959 | Texaco & others | H&C | H&C |
| Petrochemicals, Ltd... | Partington, Nr. Manchester | Exp. Ethylene Plt. | 30,000 tons/yr. | ..... | Engineering | ..... | ..... | H.W.P. | H.W.P. |
| Shell Chemical..... | Shell Haven | Ammonia; Nitric Acid | 75,000 tons/yr. | $18,500,000 | Planning | ..... | ..... | ..... | ..... |
| | | Fertiliser | ..... | $12,500,000 | Planning | ..... | ..... | ..... | ..... |
| | Partington | Ethylene Oxide | 25,000 tons/yr. | ..... | ..... | ..... | ..... | ..... | ..... |
| Shell Refining Ltd.... | Shell Haven | Atmospheric Distil. | 80,000 bbls. | ..... | Complete | ..... | ..... | S & W, Ltd. | S & W, Ltd. |
| | | *Hydrodesulfurizer & Gerbotol Unit Modifications | ..... | ..... | Under Constr. | Spring, 1959 | ..... | Lummus | Lummus |
| | | Hydrodesulfuriser | 16,000 bbls. | ..... | Projected | 1960 | ..... | ..... | ..... |
| | Stanlow | Udex Unit | ..... | ..... | ..... | ..... | UOP | ..... | ..... |
| South Eastern Gas Board | Isle of Grain | Cat. Oil Gasification | 15 Mmcf | ..... | Under Constr. | ..... | ..... | Power Gas | Power Gas |
| Southern Gas Board.. | Southampton | Refinery Tail Gas Reforming | 16 Mmcf | ..... | Under Constr. | ..... | ..... | H & G | H & G |
| | Reading | Catalytic Oil Gasification | 7 mm cfd | ..... | Under Constr. | Early 1959 | ..... | Power-Gas | Power-Gas |
| **France** | | | | | | | | | |
| Compagnie de Raffinage Shell Berre | Petit Couronne | Distl. Unit | 80,000 bbls. | ..... | Under Constr. | ..... | ..... | ..... | ..... |
| | | Hydrodesulfuriser | 11,000 bbls. | ..... | Under Constr. | 4th Qtr. 1959 | ..... | ..... | ..... |
| | | Platformer | 14,000 bbls. | ..... | Engineering | 1959 | ..... | Procon | Procon |
| Shell-Berre..... | Berre | Furfural Unit | 3,500 bbls. | ..... | ..... | ..... | ..... | Foster Wheeler | Foster Wheeler |
| Comp Francaise de Raffinage | Provence | Powerformer | 20,000 bbls. | ..... | Complete | ..... | ..... | Foster Wheeler | Foster Wheeler |
| Compagnie Francaise de Petrole; | Normandie | Ethylene Plt. | 30,000 tons/yr. | ..... | Under Constr. | Early, 1959 | ..... | KIC | ..... |
| Compagnie Francaise de Raffinage; Pechelbronn Socantar | Strasburg | Refinery | 70,000 bbls. | ..... | Planning | ..... | ..... | ..... | ..... |
| Lorraine-Dieuze (Moselle) Kuhlman | ..... | Polyethylene | ..... | ..... | Under Constr. | ..... | Koppers | Kuhlman | ..... |
| Naphtachimie..... | Lavera | Ethylene Oxide Expansion | 31,000,000 lb./yr. | ..... | Engineering | ..... | Scientific Design | Societe Francais des Services Techniques | Societe Francais des Services Techniques |
| Esso Standard..... | Gironde Bordeaux | Refinery | 31,500 bbls. Expandable to 45,000 bbls. | ..... | Under Constr. | 1959 | Esso | Lummus | Lummus |
| Esso Standard..... | Port Jerome | Powerformer | 11,900 bbls. | ..... | Under Constr. | ..... | Esso | Foster Wheeler | Foster Wheeler |
| | | Steam Cracker | 5,000 bbls. | ..... | Under Constr. | 1959 | Esso | Foster Wheeler | Foster Wheeler |
| | | Dodecylbenzene Plant | 13,500,000 tons/yr | ..... | Under Study | ..... | Esso | Foster Wheeler | Foster Wheeler |
| Houilleres du Bassin de Lorraine | Carling | Acetylene Plt. | ..... | ..... | Under Constr. | ..... | Koppers | SBA | SBA |
| | | Styrene Monomer | ..... | ..... | Under Constr. | Early 1959 | ..... | SBA | SBA |
| Manufacture Normande de Polyethylene | Gonfreville | Polyethylene | ..... | ..... | Under Constr. | ..... | Phillips | ..... | S.T.E.C. |
| Marles-Kuhlmann.... | Gonfreville | Ethylene Oxide | ..... | ..... | Under Constr. | ..... | Scientific Design | Staff | ..... |
| Mobil Oil Francaise.. | Gravenchon | Lube Exp. | ..... | ..... | Engineering 2nd phase | ..... | | | |
| | | | | | Planning 3rd phase | 1959 | | | |
| Napthachemie..... | Lavera | *Ethylene Plt. | ..... | ..... | Under Constr. | 1959 | ..... | S & W | S & W |
| Omnium Francais de Petroles | Centre Est de la France | Refinery | 75,000 bbls. | ..... | Planning | ..... | ..... | ..... | ..... |
| Potasse et Engrais Chimiques | Grand Couronne | Ammonia | ..... | ..... | ..... | ..... | ..... | Kellogg | Kellogg |
| Societe des Produits d'Aquitaine | ..... | Ammonia | 200 tons | $6,000,000 | Engineering | 1959 | ..... | Chemico | Chemico |
| | Lacq | *Acetylene from Nat. Gas | 75 tons | ..... | Under Constr | ..... | ..... | BASF | ..... |
| Societe du Caoutchouc Butyl | Port Jerome | Butyl Rubber Plt. | 20,000 tons/yr. | ..... | Under Constr. | Early, 1959 | Esso | Braun | Braun |
| Soc. Francaise des Petroles BP | Dunkirk | Cat. Reformer | 10,000 bbls. | ..... | Under Constr. | ..... | ..... | UOP; Kellogg | ..... |
| Soc. Nationale des Petroles D' Aquitaine | Lacq | Desulfurization | †140 Mmcf | ..... | Under Constr. | ..... | ..... | Foster Wheeler Soc. Chimique | Foster Wheeler Soc. Chimique |
| | | Desulfurization | 175 Mmcf | ..... | Engineering | 1959 | ..... | Foster Wheeler Soc. Chimique | Foster Wheeler Soc. Chimique |
| | | Distillation Recovery II | 112 Mmcf | ..... | Under Constr. | 1959 | ..... | Hydrocarbon; Lummus | Hydrocarbon; Lummus |
| | | Sulfur Recovery Phase II | 970 tons | ..... | Under Constr. | ..... | Parsons | Parsons, Heurtey, Soc. | Parsons, Heurtey, Soc. |
| | | Sulfur Recovery Phase III | 780 tons | $22,000,000 | Engineering | 1959 | Parsons | Parsons & Heurtey | Parsons & Heurtey |
| | | Sulfur Recovery Phase IV | 1,000 tons | ..... | Engineering | 1961 | Parsons | Parsons & Heurtey | Parsons & Heurtey |
| | | Ethylene | 25,000 tons/yr. | ..... | Engineering | 1960 | ..... | Hydrocarbon | Staff |
| **East Germany** | | | | | | | | | |
| Ministry of Coal & Energy | Rostock | Catalytic Oil Gasification | 2.4 mm cfd | ..... | Under Constr. | ..... | ..... | Power-Gas Didier | Power-Gas; Didier |

* First appearance in tabulation. † Added capacity.

*Construction BOXSCORE Continued on Page 292*

## CONSTRUCTION BOXSCORE—*Continued*

| COMPANY | Plant Site | Project | Daily Capacity | Estimated Cost | Status | Probable Completion | Licensor | Engineering | Contractor |
|---|---|---|---|---|---|---|---|---|---|
| **West Germany** | | | | | | | | | |
| B.P. Benzin und Pet A. G. | Dinslaken | Refinery | 100,000 bbls. | ..... | Under Constr. | 1960 | ..... | Kellogg | ..... |
| | | *Chemical Plt. | ..... | ..... | Engineering | 1959 | ..... | ..... | S & W |
| | | *Ethylene Plt. | ..... | ..... | Engineering | 1959 | ..... | S & W | S & W |
| Buna Werke Huels G.m.b.H. | Marl, Kreis Recklinghausen | Synthetic Rubber Plt. | 45,000 tons/yr. | $37,000,000 | Under Constr. | ..... | Esso; R&E Houdry; Firestone | Staff | Staff |
| Chemische Fabrik Holten GmbH | Lubwigshaven a Rein, Germany | Ethylene Oxide | 9,000,000 lbs./yr. | ..... | Under Constr. | ..... | Scientific Design | Scientific Design | ..... |
| Chemische Werke Huls | Marl | Polyethylene Plant | 6,000 tons/yr | ..... | Planning | Summer 1959 | Ziegler | Staff | Staff |
| Deutsche Erdol..... | Heide/Holstein | Propane-Propylene Separation | 7,000 tons/yr. Propylene | ..... | Under Constr. | ..... | Calif. Res. Hydrocarbon | Hydrocarbon, Hydro M | Staff |
| Deutsche Shell..... | Harburg | New Refinery with Crude Distiller | 40,000 bbls. | ..... | Under Constr. | ..... | ..... | ..... | ..... |
| | | Cat. Reformer Hydrodesulfurisation | | | | | | | |
| Erdolchemie GmbH.. | Dormagen (Nierderrnein) | Gasoline | 65,000 tons/yr. | ..... | Under Constr. | ..... | Lurgi/ Scientific Design | Lurgi/Scientific Design | ..... |
| | | Platformer | 6,700 bbls. | ..... | Under Constr. | ..... | UOP | UOP Procon | Procon |
| | | *Two Distl. Units. | 50,000 bbls.each | ..... | Under Constr. | ..... | ..... | ..... | ..... |
| | | *Cat Reformer | 12,500 bbls. | ..... | Under Constr. | ..... | ..... | ..... | ..... |
| | | *Hydrofiner | 10,000 bbls. | ..... | Under Constr. | ..... | ..... | ..... | ..... |
| | | *Two Copper Chloride Treaters | 2,400 bbls. each | ..... | Under Constr. | ..... | ..... | ..... | ..... |
| | Godorf | Refinery | 30,000 bbls. | ..... | Under Constr. | 1960 | ..... | ..... | ..... |
| Esso A. G..... | Cologne | Refinery | 72,000 bbls. | $30,000,000 | Under Constr. | Spring 1959 | Esso | ..... | Braun & Others |
| | | Atmospheric Crude Distill. | ..... | ..... | ..... | ..... | ..... | Braun, Uhde, Lurgi | ..... |
| | | Powerformer | 9,000 bbls. | ..... | ..... | ..... | ..... | G.H.H. | ..... |
| | | Gas-Oil Hydrofiner | 12,000 bbls. | ..... | Under Constr. | ..... | ..... | Kocks, Still | Esso |
| | | Steam Cracker | 5,600 bbls. | ..... | Under Constr. | ..... | ..... | Lurgi | Esso |
| | | Sulfur Recovery | 8,900 tons/yr | ..... | ..... | ..... | ..... | ..... | ..... |
| | Hamburg | Oil Sweetening Plant | 7,700 bbls. | ..... | Under Constr. | ..... | Esso | Lurgi | ..... |
| | | Solvents Hydrofiner | 3,040 bbls. | ..... | Under Constr. | ..... | Esso | Lurgi | ..... |
| Feldmuhle..... | Luisdorf | Ethylene | 10,000 tons/yr. | ..... | Engineering | ..... | ..... | Hydrocarbon Hydro M | Hydro M |
| Frisia..... | Emden, W. Germany | Refinery | 30,000 bbls. | $17,000,000 | Engineering | 1959 | ..... | Parsons | Parsons |
| Mobil Oil A. G..... | Bremen Oslebhausen | Crude Two Stage | 16,000 bbls. | ..... | Under Constr. | ..... | ..... | Hydrocarbon Hydro M | Hydro M |
| Purfina Mineralolraffinerie A. G. | Duisburg | Topping, Platformer Hydrodesulfuriser | 20,600 bbls. | ..... | Under Constr. | ..... | UOP, Shell | Lummus; Uhde | Lummus; Uhde |
| Rheinische Olefinwerke GmbH | Wesseling Bez. Kohn | Polyethyene Plant | ..... | ..... | Under Constr. | Mid 1959 | Phillips | Braun, Staff | ..... |
| | | Ethylene Plant | ..... | ..... | Under Constr. | ..... | Kellogg | Lurgi | ..... |
| **Ireland** | | | | | | | | | |
| Irish Refining Co..... | Whitegate | Refinery | 32,000 bbls. | $33,600,000 | Approved | 1959 | ..... | ..... | ..... |
| Esso Petr. (Ireland) Caltex (Ireland) Shell Mex., B.P. | | | 30,000 bbls. | ..... | Under Constr. | ..... | ..... | ..... | Lummus |
| **Italy** | | | | | | | | | |
| Asfalti Bitumi Cementi Derivati, S.A. | Ragusa | *Polyetilylene | 25 tons | ..... | Under Constr. | ..... | ..... | BASF | ..... |
| Azienda Nazionale Idrogenazione Combustibil | Ravenna | Styrene Monomer Plt. | 14,000 tons/yr. | ..... | Under Constr. | ..... | Koppers | SBA | SBA |
| | | Butadiene Plt. | 22,000 tons yr. | ..... | Engineering | Fall, 1959 | Houdry | Catalytic | ..... |
| | | Ethylene Plant | ..... | ..... | Under Constr. | ..... | Koppers | ANIc | ..... |
| Destilleris Italiane... | Milano | Butanol | 11,000 tons/yr. | ..... | Engineering | ..... | Hoechst | Uhde | Uhde |
| Ftalital, S.p.a..... | Italy | Maleic Anhydride | 2,200,000 lb./yr. | ..... | Engineering | ..... | Scientific Design | Scientific Design | ..... |
| I.R.O.M..... | Venice | Hydrofiner | 6,500 bbls. | ..... | Engineering | 1959 | ..... | SNAM | SNAM |
| Isiom..... | Palermo | Refinery | 15,000 bbls. | ..... | Planning | ..... | ..... | Staff | ..... |
| Mobil Oil Italiana S. p.a | Naples | Cat. Reforming | 9,000 bbls. | ..... | Under Constr. | ..... | ..... | CTIP | CTIP |
| | | Cat. Hydrodesulfurisation | 10,000 bbls. | ..... | Under Constr. | ..... | ..... | CTIP | CTIP |
| | | Lube Expansion | ..... | ..... | Under Constr. | ..... | ..... | Staff | Staff |
| Montecatini Societe Generale per l'Industria Mineraria Chimica | Ferrara | Exp. Polypropylene | ..... | ..... | Planning | 1959 | ..... | ..... | ..... |
| | Castellanza | Increase Formaldehyde | 135,000,000 lbs/yr | $300,000 | Under Constr. | ..... | ..... | ..... | ..... |
| Shell Italiana..... | Palermo | Refinery | 20,000 bbls. | ..... | Planning | ..... | ..... | ..... | ..... |
| Sincat..... | Priolo, Sicily | Ammonia Unit | 150 tons | ..... | ..... | ..... | ..... | Foster Wheeler | Foster Wheeler |
| | | *Ethylene Plt. | ..... | ..... | Engineering | 1959 | S & W | S & W | ..... |
| | | *Treating Plt. | ..... | ..... | Engineering | 1959 | ..... | S & W | ..... |
| Snia Viscosa..... | Varedo, near Milan | *Carbon Disulfide | ..... | ..... | Under Constr. | 1960 | Food Machinery & Chemical | ..... | ..... |
| **Spain** | | | | | | | | | |
| Soc. Solvay & Cia | Italy | Polyethylene | ..... | ..... | Licensed | ..... | Phillips | ..... | ..... |
| **Netherlands** | | | | | | | | | |
| B. F. Goodrich & Algemene Kunstsijde Unie | Arnheim | Butadiene | ..... | ..... | ..... | Mid 1959 | ..... | ..... | ..... |
| Kunstsijde Unie N.V. | ..... | Styrene Plant | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| Esso Nederland..... | Rotterdam | Refinery | 95,000 bbls. | $50,000,000 | Under Constr. | Early 1960 | Esso | Badger Comprimo N.V. | Badger, Comprimo N.V. |
| **Norway** | | | | | | | | | |
| Standard (N.J.)..... | Oslo Fjord | Refinery | 40,000 bbls. | $30,715,000 | Engineering | Late, 1960 | Esso | Esso | ..... |
| **Portugal** | | | | | | | | | |
| Ammoniaco Portugues | Estarreja. | Ammonia | 40 tons | ..... | Under Constr. | ..... | Uhde | Uhde | Uhde |
| **Rumania** | | | | | | | | | |
| Rumanian Govt..... | Teleajen | *Lube Oil | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| | | *Natural Gas Treating | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| | Borzesti | *Petrochemical Plt. | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| | Onesti | *Synthetic Rubber | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| **South Africa** | | | | | | | | | |
| Caltex..... | Durban | *Refinery | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| **Scotland** | | | | | | | | | |
| British Hydrocarbon Chemicals | Grangemouth | Polyethylene Plt. | 25,000,000 lbs./yr. | ..... | Under Constr. | Early 1959 | Phillips | S & W | ..... |
| | | Cumene Plt. | ..... | ..... | Engineering | Mid 1959 | Mid-Centry Corp. | Scientific Design S & W | ..... |
| | | Phenol | ..... | ..... | Under Constr. | 1959 | Distillers Co., Ltd. | S & W | ..... |
| Britsh Petroleum... | Grangemouth | Copper Chloride Unit | 2,000 bbls. | ..... | Under Constr. | ..... | ..... | Power-Gas | Power-Gas |
| | | Kerosine Treating | 2,000 bbls. | ..... | Under Constr. | ..... | ..... | Power-Gas | Power-Gas |
| | | Deethanizer | 625 bbls. | ..... | Under Constr. | ..... | ..... | Power-Gas | Power-Gas |

* First appearance in tabulation. † Added capacity.

*Construction BOXSCORE Continued on Page 295*

Tuffy. Tips On **SAFE USE OF SLINGS AND HOIST LINES**

# Lifting Strains Take High Toll of Injuries

Did you know that in some states one in every six compensation claims involves back injuries? And that one insurance company says back injuries constitute 60% of their claim expense?

Hernia is another hazard of materials handling. One manufacturer reported 75% of his compensation claims involved hernias. This high incidence of hernias and back injuries can be greatly reduced by proper lifting equipment and methods.

### What can you do to reduce materials handling accidents? Here are some of the answers:

**1. Teach** your workers rated load factors. Warn them not to overload slings.

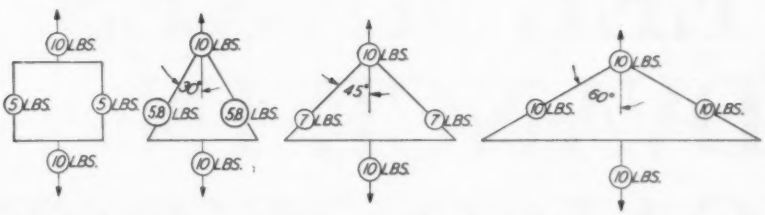
**2. Use** the right size hoist for every heavy lifting job. Don't put the load on human muscle.

**3. Show** workers how to rig hoists properly and safely. Load chains shouldn't be used as slings. Previous distortion and weakening of links may cause them to break even with a light load.

**4. Inspect** hoist load brakes often. Slipping or dragging brakes should never be used.

**5. Be sure** to use the proper sling for the job. Don't assume that all slings made of wire rope are right for all lifting operations.

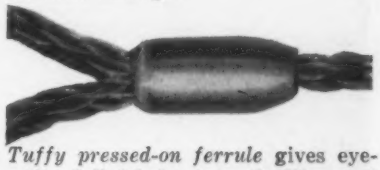
### How Sling-Leg Load Increases with Increased Fleet Angle




These four drawings show approximate load increases on each leg of a bridle sling as the vertical angle of spread between legs increases. For accurate factors for the various angles, refer to your Tuffy Sling Handbook. (Don't have one? Write Union Wire Rope Corporation. Specialists in high carbon wire, wire rope, braided wire fabric and stress relieved wire and strand. 2284 Manchester Avenue, Kansas City 26, Missouri.)

### Why Tuffy Slings Do A Better Job More Safely

*Tuffy Slings* have a combination of extra strength and super flexibility. The patented machine-braided fabric is the secret. It gives Tuffy greater strength, faster handling, longer life, greater safety than ordinary slings—at a cost to service life ratio that figures low. And it's so flexible that kinks can be pounded out without material damage.



*Tuffy pressed-on ferrule* gives eye-splice full fabric strength. The steel ferrule is applied under tremendous pressure. It literally flows into spaces between wires and strands. The friction force thus created gives the eye-splice 100% of the fabric strength. And the streamlined Tuffy ferrule leaves no openings or rough projections to snag or injure hands.

*Tie a knot* in a Tuffy Sling? Pull it as tight as you can. Even if you kink it, it's still easy to straighten out with no material damage to the sling.

### *See Your Tuffy Distributor*

**He's stocked for fast delivery of all your Tuffy Slings and Union Wire Rope needs.**

### Get Your FREE Tuffy Sling Handbook

Gives full data on Tuffy Slings. Types, dimensions, weights and rated loads. Also contains an expanded section on fittings — many not previously shown. Write for your copy now.

**UNION Wire Rope**

*Subsidiary of* ARMCO STEEL CORPORATION

OTHER SUBSIDIARIES AND DIVISIONS: Armco Division • Sheffield Division • The National Supply Company Armco Drainage & Metal Products, Inc. • The Armco International Corporation • Southwest Steel Products

*Blaw-Knox builds pace setting nitrogen plant for Columbia-Geneva Steel Division of U.S. Steel Corporation.* This is the first U.S. installation in a major steel plant to use coke oven gas as the source of hydrogen for ammonia production. Located near Provo, Utah, the new plant includes administration, maintenance and compression buildings . . . ammonia synthesis, storage and shipping . . . nitric acid production, ammonium nitrate production, prilling, packaging and shipping.

# U.S. STEEL MAKES NEW ADVANCE IN CHEMICAL OUTPUT

Anhydrous ammonia, oxygen, sulfuric acid, nitric acid, ammonium nitrate solids and solutions . . .

A world wide effort: From Italy, Montecatini provided processes for gas purification, ammonia synthesis and nitric acid production. From Germany, the German-Linde Company supplied low temperature air and gas separation units . . . and, for the first time in this country, the famous Lurgi process is used for sulfuric acid production.

Blaw-Knox Company, Chemical Plants Division with headquarters in Pittsburgh. Branch offices in New York, Chicago, Haddon Heights, New Jersey, Birmingham, Washington, D. C., and San Francisco.

*for plants of distinction . . .*

BLAW-KNOX

## CONSTRUCTION BOXSCORE—*Continued*

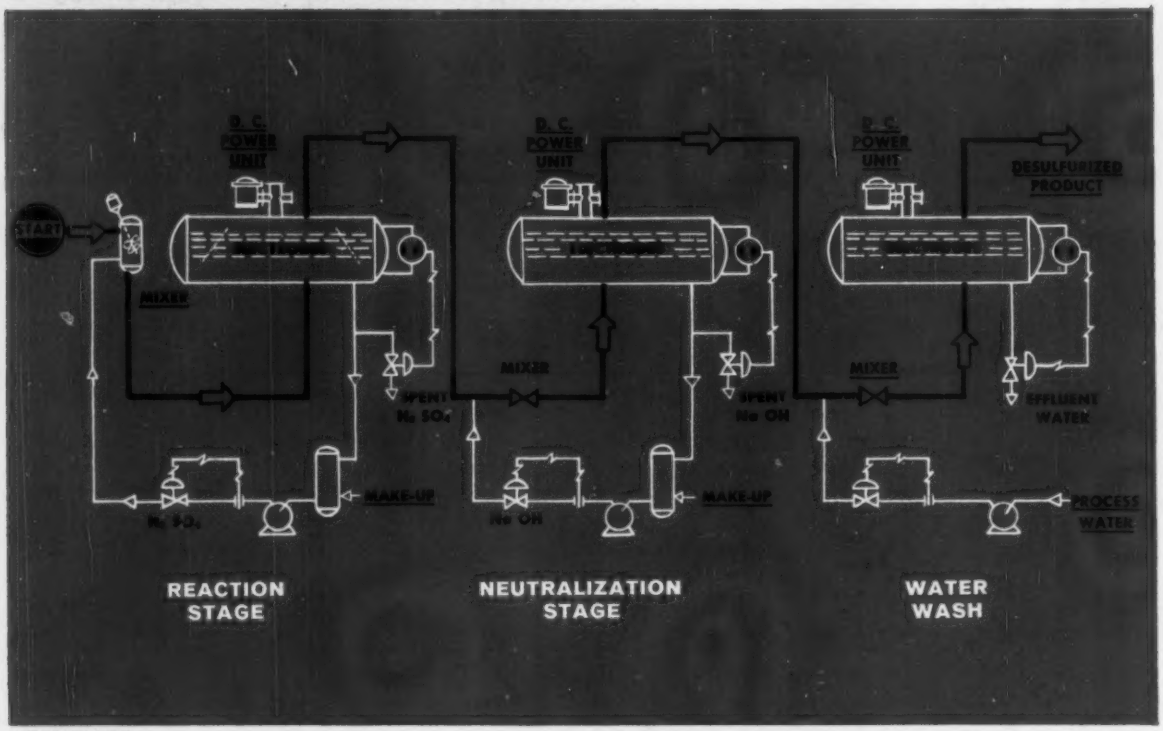
| COMPANY | Plant Site | Project | Daily Capacity | Estimated Cost | Status | Probable Completion | Licensor | Engineering | Contractor |
|---|---|---|---|---|---|---|---|---|---|
| **Spain** | | | | | | | | | |
| Hidro Nitro Espanola | Monzon | Ammonia Synthesis | 22 tons | ..... | Under Constr. | 1958 | ..... | Uhde | Uhde |
| Refineria de Petroleos de Escombreras S.A. | Escombreras | | | | | | | | |
| **Sweden** | | | | | | | | | |
| A. Johnson & Co. | Sweden | Refinery Exp. | ..... | ..... | Under Constr. | ..... | ..... | Bechtel | Bechtel |
| Stockholm Gas & Water Works | Stockholm | Cat Oil Gasification | 4 Mmcf | ..... | Under Constr. | Mid 1959 | Power Gas | ..... | Power Gas |
| **Turkey** | | | | | | | | | |
| Badische Anilin and Soda Fabrik | Kutahya | Ammonium Sulfate<br>Sulfuric, Nitric Acid | 60,000 tons/yr.<br>50,000 tons /yr. | $20,000,000 | Under Constr. | ..... | Badische Anilin & Soda-Fabrik AG | Badische Anilin & Soda-Fabrik AG. | ..... |
| Mobil Overseas, Shell, Cal-Tex, BP | Turkey | Refinery | 65,000 bbls. | $48,000,000 | Under Constr. | ..... | ..... | ..... | ..... |
| Turkish Government | Istanbul | Natural Gasoline Plt. | ..... | ..... | Planning | ..... | ..... | ..... | ..... |
| **Union of South Africa** | | | | | | | | | |
| Standard-Vacuum | Durban | Refinery Exp. | 25,000 bbls. | $9,000,000 | Engineering | ..... | ..... | Foster Wheeler | Foster Wheeler |
| | | Powerformer | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| | | Hydrofiner | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| | | Steam Plt. | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| **Yougoslavia** | | | | | | | | | |
| Yougoslav Government | Dubrovnik | Distill. and Treating | 1,350 bbls. | $1,350,000 | Planning | 1960 | ..... | Institute of Petroleum at Zagrel | ..... |
| | Sisak | Topping and Stabilising | 7,500 bbls. | ..... | Planning | 1961 | ..... | Institute of Petroleum at Zagrel | ..... |
| | | Ammonia Plt. | 120 Tons | $15,000,000 | Planning | 1962 | ..... | ..... | ..... |
| | Pancevo | Ammonia Plt. | 250 Tons | ..... | Planning | 1962 | ..... | ..... | ..... |
| | Zagrel | Reformer | ..... | ..... | Planning | ..... | ..... | ..... | ..... |
| **NEAR EAST** | | | | | | | | | |
| **Egypt** | | | | | | | | | |
| Anglo-Egyptian Oilfields | Sues | Cat. Reformer | 2,300 bbls. | ..... | Projected | ..... | ..... | ..... | ..... |
| Egyptian Chem. Ind., KIMA S.A.E. | Aswan | *Ammonia Plt. | 315 tons | ..... | Under Constr. | 1960 | BASF | BSAF | BSAF |
| Egyptian Govt. | Sues | Power Plt. | 10,000 KW. | $2,200,000 | Planned | 1959 | ..... | Italian | Firms |
| | | Atmos. Dist., Vac. Dist. & Lube Oils | 20,000 bbls. | $7,000,000 | Planning | 1960 | ..... | ..... | ..... |
| | | Cat Reformer | 3,000 bbls. | $2,700,000 | Planning | 1962 | ..... | ..... | ..... |
| | | Hydrodesulfuriser | 2,700 bbls. | $720,000 | Planning | 1962 | ..... | ..... | ..... |
| | | Lube Oils | ..... | $9,000,000 | Planning | 1963 | ..... | ..... | ..... |
| | | Vapor Recovery & Bottling | 70 tons | $1,000,000 | Planned | 1959 | ..... | Lummus | Lummus |
| | Alex | Atmos. & Vac. Dist. | 10,000 bbls. | $1,400,000 | Planning | ..... | ..... | ..... | ..... |
| | Cairo | Atmos. Dist. & Vac. Dist. | 10,000 bbls. | $1,400,000 | Planning | ..... | ..... | ..... | ..... |
| **Iraq** | | | | | | | | | |
| Iraq Government | Baghdad | Refinery Exp. | 48,000 bbls. | $11,000,000 | Under Constr. | July, 1959 | Esso | Foster Wheeler | Foster Wheeler |
| | | Powerformer | 5,000, bbls. | ..... | ..... | Sept., 1959 | ..... | Foster Wheeler, Ltd. | Foster Wheeler, Ltd. |
| | | Kerosine Treating Unit | 5,000 bbls. | ..... | ..... | Sept., 1959 | ..... | Foster Wheeler | Foster Wheeler |
| | Qaiyarah | Refinery Revamp Crude Topping; Vacuum Distill.; Thermal Cracking; Asphalt | 7,500 bbls. | ..... | Planning | Late 1959 | ..... | ..... | ..... |
| **Israel** | | | | | | | | | |
| Fertilisers & Chemicals, Ltd. | Haifa Bay | Ammonia Plt. Exp. Fertilisers | 50 tons | $5,000,000 | Engineering | 1959 | ..... | Staff Lurgi | Local |
| **Kuwait** | | | | | | | | | |
| Kuwait Oil | Mina al Ahmadi | Hydrobon Platformer | 4,070 bbls. | ..... | Under Constr. | Early 1959 | UOP | Procon | Bechtel-Kuwait |
| | | Prefractionator | 7,200 bbls. | ..... | Under Constr. | Early 1959 | UOP | Procon | Bechtel-Kuwait |
| **Neutral Zone** | | | | | | | | | |
| Getty Oil Co. | Neutral Zone | Crude Stripping | 50,000 bbls. | $2,000,000 | Under Constr. | ..... | ..... | Parsons | Parsons |
| **Pakistan** | | | | | | | | | |
| Pakistan Industrial Dev. Corp. | Fenchanj, Pakistan | Ammonia<br>Urea | 225 tons<br>375 tons | $20,000,000 | Engineering | 1961 | Kobe Steel | Chemico | Chemico |
| **Saudi Arabia** | | | | | | | | | |
| Arabian American Oil | Ras Tanura | Alkylation Unit | 1,210 bbls. | $6,990,000 | Under Constr. | Mid 1959 | Kellogg | Kellogg/Aramco | Staff |
| | | LPG Processing Handling, and Loading Facilities | 1,500 bbls. | $1,025,000 | Under Constr. | January, 1959 | Kellogg | Staff | Staff |
| **Syria** | | | | | | | | | |
| Syrian Government | Homs | Refinery | 20,000 bbls. | $11,000,000 | Planning | ..... | ..... | ..... | ..... |
| **FAR EAST** | | | | | | | | | |
| **Ceylon** | | | | | | | | | |
| Shell of Ceylon | Hendola | Refinery | ..... | $40,000,000 | Planning | ..... | ..... | ..... | ..... |
| **China** | | | | | | | | | |
| Hong Kong & China Gas Company | Hong Kong | Catalytic Oil Gasification | 1.5 mm cfd | ..... | Under Constr. | Autumn 1959 | Hercules | Power-Gas | Power-Gas |
| **India** | | | | | | | | | |
| Alkali & Chemical Corp. of India | India | Polyethylene Plt. | ..... | $6,300,000 | Under Constr. | Early 1959 | I. C. I. | ..... | Simon Carves, Ltd. |
| Indian Government | Assam | *Refinery | 750,000 tons | $17,000,000 | Under Constr. | ..... | ..... | Rumanian Government | Rumanian Government |
| New Central Jute Mills | Varaussi | Ammonia | 45 tons | ..... | Under Constr. | ..... | Uhde | Uhde | Uhde |
| Standard Vacuum | Bombay | Asphalt Plant | ..... | $2,500,000 | Engineering | Late 1959 | ..... | Parsons | Parsons |
| **Japan** | | | | | | | | | |
| Asahi-Dow | Kawasaki | Styrene Monomer | ..... | ..... | Under Constr. | 1960 | Dow | Dow | Dow |
| Befu Chemical | Befu Harbor Honshu | Ammonia Plt. | ..... | ..... | Under Constr. | ..... | Texaco | Chemico | Chemico |
| Daikyo Oil Co. | Yokkaichi | Topping & Vacuum | 30,000 bbls. | ..... | Under Constr. | Mid 1959 | ..... | Japan Gasoline | Japan Gasoline |
| Furukawa Chemical Industries | Japan | Polyethylene | ..... | ..... | Under Constr. | Spring, 1959 | Standard (Ind.) | ..... | ..... |
| Idemitsu Kosan Co. | Tokuyama | Unifiner | 6,000 bbls. | $370,000 | Engineering | ..... | UOP | UOP; J.G.C. | J.G.C. |
| Japan Synthetic Rubber | Yokkaichi | Butadiene & GR-S Rubber Plant | 33,500 tons/yr | $30,000,000 | Under Constr. | 1959 | Houdry<br>Esso<br>Goodyear | Blaw-Knox; Catalytic | ..... |
| Kon Oil. | Iwakuni | Fluid Cat Cracker | 5,500 bbls. | ..... | Planning | Late 1959 | UOP | ..... | ..... |
| | | Delayed Coker (Thermal Cracker revamp) | 4,500 bbls. | ..... | ..... | Late, 1959 | UOP | ..... | ..... |
| | | *Vacuum Distl. Unit | 10,000 bbls. | ..... | Planning | Late 1959 | UOP | ..... | ..... |

* First appearance in tabulation. † Added capacity.

*Construction BOXSCORE Continued on Page 299*

# NEW HOWE-BAKER PROCESS CUTS

## *Electrostatic Desulfurization Process*




**HOWE-BAKER PROCESS:** **ELECTROSTATIC MIXING AND COAGULATION PERMITS VIRTUALLY COMPLETE REMOVAL OF SULFUR BY ACID TREATING, WITH SAVINGS OF ROUGHLY 60% OVER THE INITIAL AND OPERATING COSTS OF HYDRODESULFURIZATION.**

**APPLICATION:**
Reduction of sulfur concentrations in naphtha feed stocks from 0.02—1.2 weight per cent to 0.002—0.005 in the treated products. Successfully applied to sulfur reduction in middle distillates such as kerosene and diesel.

**DESCRIPTION:**
Mechanical (propellor) mixing of acid and oil reduces particle size of the acid to optimum colloidal dimensions for maximized surface area. Entering the electrical field in the reaction stage, these particles are violently excited, maximizing random contact with sulfur molecules (electrostatic mixing). Sufficient electrical potential is imposed in the upper portion of the field to enhance random contact of any two acid (or caustic) particles, coalescing them. Coalescing action is sustained until particles accumulate sufficient mass to fall to the vessel bottom by gravity. Acid carry-over is neutralized in the second treating stage with weak caustic. Carry-over of sodium from final stage is nil.

**PRODUCTION CREDITS:**
Essentially complete removal of sulfur and trace metals. *Carry-Over of Treating Agent* eliminated by electrical coagulation. *Undesirable Side Reactions* (esterification and sulfonation) are prevented by ambient reaction temperatures and low holdup time. *Poor Pumpability* of acid due to formation of gummy polymers is prevented by positive pressure (oxygen-free).

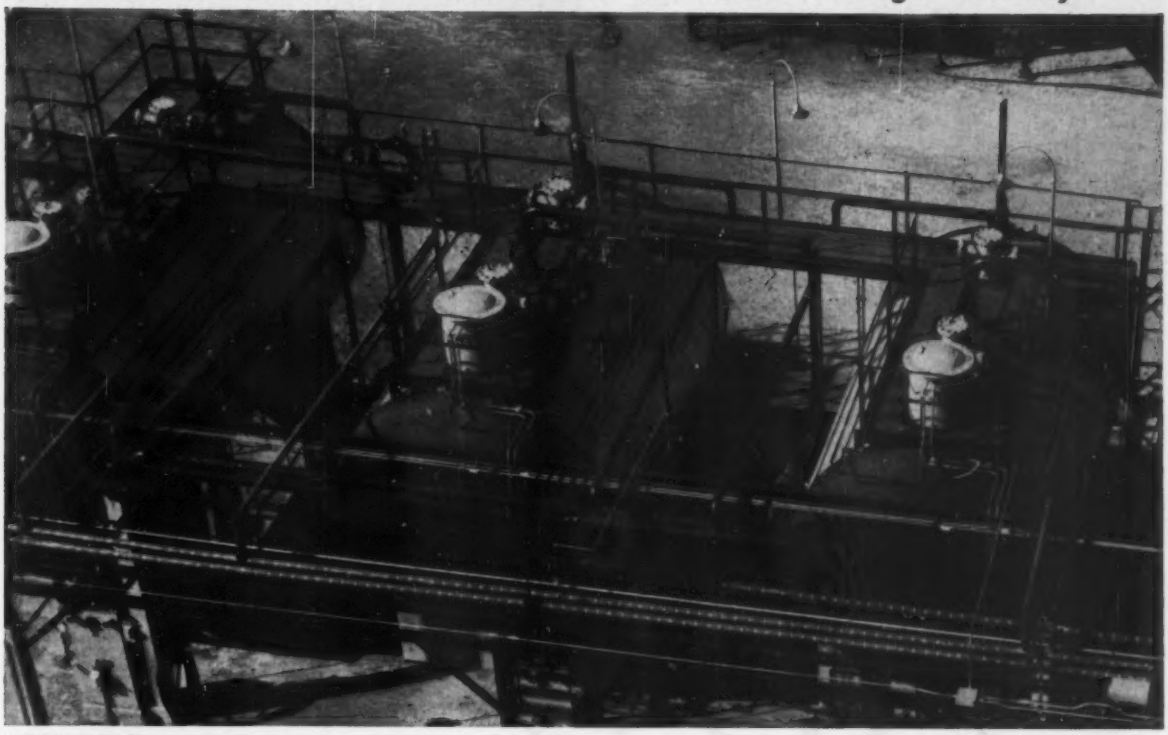
**ECONOMIC CREDITS:**
*Total Installed Cost* is about 40% of the cost of hydrodesulfurization units, with substantial reductions when existing vessels can be employed. *Operating Costs* average less than 5 cents per barrel, or about 40% of the cost of hydrodesulfurization, with further reductions if alkylation acid is available. Normal electrical operating load is only 3KVA. Mechanical failures are nil, due to low operating temperatures and pressures, absence of moving parts, "over-designed" electrical components (in terms of normal versus maximum load). *Labor Time* is restricted to one hour per shift for sampling, instrument readings, etc. One annual inspection is adequate. *Yield Losses* are less than 0.5% when treating virgin naphthas.

**COMMERCIAL INSTALLATIONS:**
In addition to the Cities Service unit already in operation, startups of two more plants are scheduled for the first quarter of 1959, showing the unusually rapid acceptance of the new process. About 25 other units are now under consideration.


For more data on advertised products, use Readers' Service Cards, last page.

# COST OF DESULFURIZATION BY 60%!

*New CITIES SERVICE Desulfurization Unit - East Chicago Refinery*



**CITIES SERVICE PLANT:** TREATS 8,000 BPSD OF NAPHTHA FEED TO CATALYTIC REFORMER, REDUCING SULFUR CONTENT IN PRODUCT TO APPROXIMATELY 25 PPM, WITH NEGLIGIBLE PRODUCT DEGRADATION AND SLUDGE LOSS.

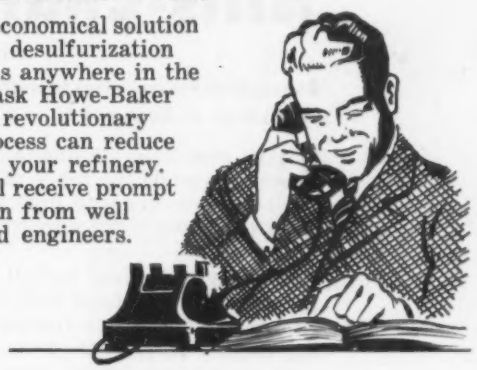
**PRODUCT INSPECTION**

| NAPHTHA: | CHARGE | PRODUCT |
|---|---|---|
| Gravity, °API | 57.2 | 57.2 |
| Distillation, °F | | |
| Initial Boiling Point | 185 | 186 |
| 10% | 230 | 230 |
| 50% | 270 | 270 |
| 90% | 325 | 328 |
| End Point | 363 | 364 |
| Sulfur, ppm | 300 | 22 |
| Arsenic, ppb | 5-17 | 5-1 |
| Chlorides, ppm | 2.0 | 1.0 |
| Lead, ppb | 5-9 | 5-3 |
| Nitrogen (total), ppm | 2.0 | 1.0 |
| Nitrogen (basic), ppm | Nil | Nil |
| Sodium ion, ppm | Nil | Nil |
| | FRESH | SPENT |
| ACID STRENGTH, % | 90.9 | 80.0 |

## CUT YOUR COSTS NOW!

**CALL HOWE-BAKER TODAY**

For an economical solution to your desulfurization problems anywhere in the world, ask Howe-Baker how its revolutionary new process can reduce costs in your refinery. You will receive prompt attention from well qualified engineers.



## HOWE-BAKER ENGINEERS, INC.

THROUGH SPECIALIZATION, PROVEN ENGINEERING

UNCONDITIONALLY GUARANTEED TO PERFORM AS SPECIFIED

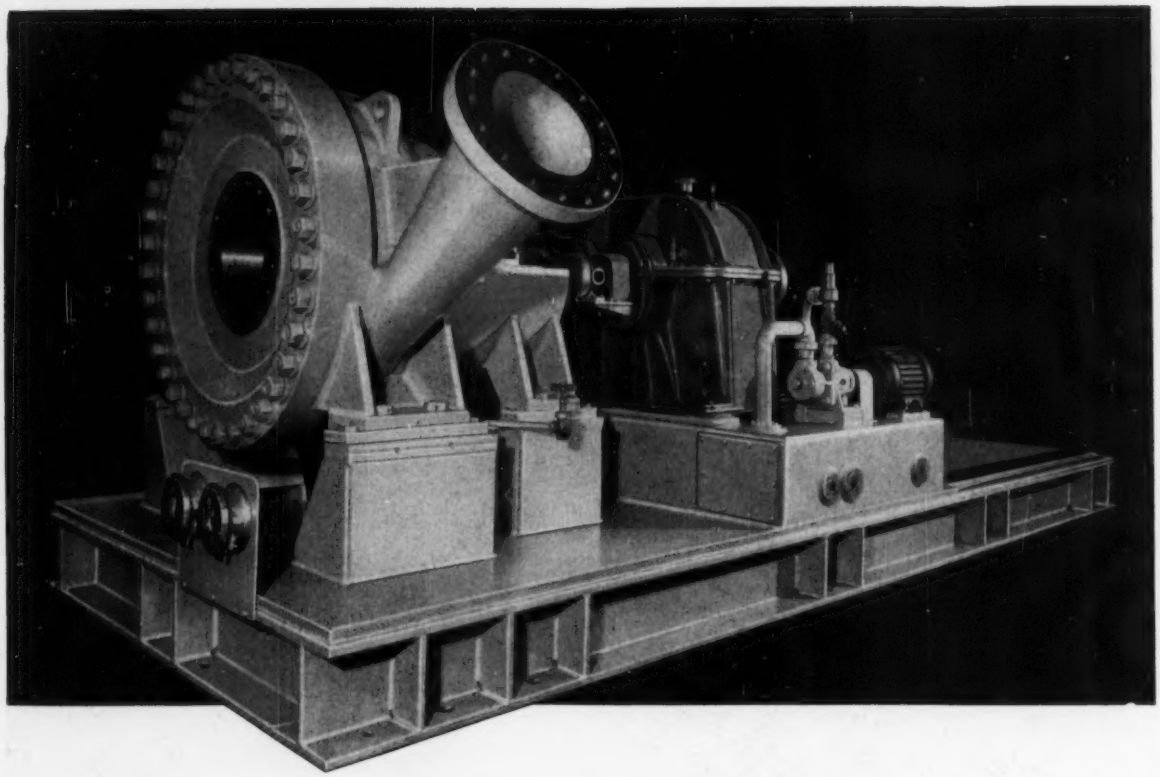
EASTERN DIVISION:
35 LEONARD DRIVE • WESTWOOD, NEW JERSEY

SOUTH AMERICAN REPRESENTATIVE:
ACHABE, S. A. • APARTADO 4668, CHACAO • CARACAS, VENEZUELA

HEADQUARTERS: TYLER, TEXAS • PHONE LY 3-6411



For more data on advertised products, use Readers' Service Cards, last page.



# NEW

## Single-Stage Barrel-Type
## Allis-Chalmers Compressor

**Boosts High Pressure Gas to Higher Pressure Levels in Range of 50 to 500 psia.**

THIS new Allis-Chalmers development extends the range of single-stage compressors into high pressure levels previously handled by reciprocating type units.

The new compressor has all the advantages of a centrifugal compressor — compactness, pulsation-free operation, few wearing parts, easy maintenance.

The unit shown above, now in successful operation, boosts 3690 cfm of air from an inlet pressure of 185 psia to a discharge pressure of 240 psia. It is driven through a speed-up gear by an Allis-Chalmers 1250-hp motor.

The casing consists of three principal parts: the casing cylinder, a bolted casing head and a fabricated casing pedestal. A diaphragm which forms the gas diffuser passage is inserted into the casing cylinder. Excellent gas sealing is assured, since there is only one shaft extension and only one casing joint to seal against gas pressure.

For details, including a sectional view of this new compressor, call your nearby A-C representative, or write Allis-Chalmers, Industrial Equipment Division, Milwaukee 1, Wisconsin.

**ALLIS-CHALMERS**

A-5728



For more data on advertised products, use Readers' Service Cards, last page.

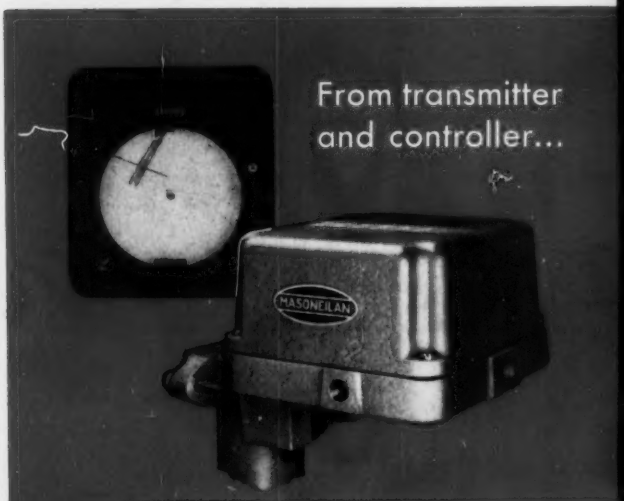
## CONSTRUCTION BOXSCORE—*Continued*

| COMPANY | Plant Site | Project | Daily Capacity | Estimated Cost | Status | Probable Completion | Licensor | Engineering | Contractor |
|---|---|---|---|---|---|---|---|---|---|
| Maruzen Oil Co..... | Matsuyama | Udex Unit | 1500 bbls. | $2,200,000 | Under Constr. | ..... | UOP | UOP; Japan Gasoline Co. | J.G.C. |
| | | Benzene | 6 600 tons/yr | ..... | ..... | ..... | UOP | ..... | ..... |
| | | Toluene | 4,000 tons/yr | ..... | ..... | ..... | UOP | ..... | ..... |
| | | Xylene | 4,000 tons/yr | ..... | ..... | ..... | UOP | ..... | ..... |
| | | Oxidation Unit | 20 tons | $4,000,000 | Engineering | March, 1959 | Scientific Design | Scientific Design | Scientific Design |
| | | Benzoic Acid | 900 tons/yr | ..... | ..... | April, 1960 | Scientific Design | ..... | ..... |
| | | Phthalic Acid Anhydride | 2,245 tons/yr | ..... | ..... | April, 1960 | Scientific Design | ..... | ..... |
| | | Isophthalic Acid | 5,600 tons/yr | ..... | ..... | April, 1960 | Scientific Design | ..... | ..... |
| | | Terephthalic Acid | 2,500 tons/yr. | ..... | ..... | April, 1960 | Scientific Design | ..... | ..... |
| | Osaka | Secondary Butyl Alcohol | 15 tons | ..... | ..... | ..... | ..... | Chemical Projects Assoc. | Chiyoda |
| Mitsui Petrochemical Industries | Iwakuni City | Phenol Unit | 1,000 tons | ..... | Complete | ..... | Distillers, Ltd. | S&W | S&W |
| | | *Terephthalic Acid Plt. | ..... | ..... | Under Constr. | Sept., 1959 | Scientific Design | Scientific Design | Mitsui Shipbuilding |
| | | *Paraxylene Plt. | ..... | ..... | Engineering | Sept., 1959 | Scientific Design | Scientific Design | ..... |
| | | Cat Reformer | ..... | ..... | Licensed | ..... | ..... | ..... | ..... |
| | | Paraxylene Plant | ..... | ..... | ..... | Summer 1959 | ..... | Scientific Design | ..... |
| Mitsubishi Petrochemical Co. | Yokkaichi | Styrene Monomer | 55.4 tons | ..... | Under Constr. | Jan., 1959 | B.P.M. | B.P.M.; Chiyoda | B.P.M.; Chiyoda |
| | | Ethylene Oxide | 9.2 tons | ..... | Engineering | ..... | Scientific Design | Scientific Design | ..... |
| | | Ethylene Glycol | 9.2 tons | ..... | Engineering | ..... | Scientific Design | Scientific Design | ..... |
| Nihon Gas Kagaku Kogyo | Niigata | Urea | 95 tons | ..... | ..... | ..... | ..... | Chemico | Chemico |
| | | Ammonia Sulfate | 200 tons | ..... | ..... | ..... | ..... | ..... | ..... |
| Nippon Oil Co..... | Niigata | Platformer | 1,600 bbls. | $1,500,000 | Complete | ..... | UOP | UOP; J.G.C. | UOP; J.G.C. |
| Nippon Petroleum Refining | Yokohama | Lube Oil Furfural Unit | 700 bbls. | $1,000,000 | Complete | ..... | Texaco | Chiyoda | Chiyoda |
| Nippon Petrochemicals | Kawasaki | Ethylene | 25,000 tons/yr. | $16,000,000 | Engineering | Spring, 1959 | S&W Esso | S&W; J.G.C. | S&W; J.G.C. |
| | | Butadiene | 5,000 tons/yr. | | | | | | |
| Showa Denko KK.. | Tokyo | Synthesis Gas Plt. | 121 Short tons | ..... | ..... | ..... | Texaco | Foster Wheeler | Foster Wheeler |
| Showa Yuka..... | Japan | Polyethylene | ..... | ..... | Under Constr. | 1st Qtr. 1959 | Phillips | Staff, Braun | ..... |
| Toa Nenryo Kogyo... | Shimizu | Ref. Exp, Powerformer; Hydrofiner; Kerosine Acid treating; Copper Sweetener; Offsite Facilities | 43,500 bbls. | $12,500,000 | Under Constr. | ..... | ..... | ..... | ..... |
| **Korea** | | | | | | | | | |
| Korean Government.. | Chung-ju | Urea Plt. | 285 tons | $25,000,000 | Under Constr. | ..... | Inventa-Vulcan | Hydrocarbon, McGraw, Vulcan | Hydrocarbon, McGraw |
| **Taiwan (Formosa)** | | | | | | | | | |
| Chinese Petroleum Corp. | Kaohsiung | Alkylation Unit | 900 bbls. | $1,800,000 | Engineering | ..... | Texaco | Badger | Staff |
| | | Sulfur Recovery Unit | 10 tons | $300,000 | Engineering | ..... | ..... | Pintsch Bamag | Staff |
| **Thailand** | | | | | | | | | |
| Thai Defense Ministry | Bangkok | Refinery | 5,000 bbls. | $20,000,000 | ..... | ..... | ..... | Japanese Fuji Company | Japanese Fuji Company |
| **AUSTRALASIA** | | | | | | | | | |
| **Australia** | | | | | | | | | |
| Bitumen & Oil Refineries | Sydney | Diesel Unifiner | 2,500 bbls | ..... | Under Constr. | ..... | ..... | UOP | Staff |
| | | Crude Unit | 12,000 bbls. | ..... | Proposed | ..... | ..... | Procon | Procon |
| BP Refinery (Kwinana) | Kwinana | Cat. Reformer | 10,000 bbls. | $9,200,000 | Under Constr. | 1959 | ..... | UOP, Kellogg | Kellogg |
| Imperial Chemical Industries of Australia & New Zealand | Australia | Polyethylene Plt. | 3,500 tons/yr. | $5,040,000 | ..... | ..... | ..... | ..... | ..... |
| Shell Oil..... | Newport | *Oil Blending Plt. | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| Shell Refining (Australia) | Clyde | Platformer | 6,700 bbls. | ..... | Under Constr. | ..... | UOP | ..... | Procon |
| | Geelong | Hydrodesulfurizer | 11,000 bbls. | ..... | Projected | 3rd Qtr., 1959 | ..... | ..... | ..... |
| Standard Vacuum.... | Melbourne | Refinery Revamp | ..... | ..... | Under Constr. | Mid 1959 | ..... | Fluor | Fluor |
| | Adelaide | Refinery | 30,000 bbls. | $30,000,000 | Planning | ..... | ..... | ..... | ..... |
| **Philippine Islands** | | | | | | | | | |
| Gulf Oil..... | Luzon | Refinery | 10,000 bbls. | ..... | Planning | Late 1960 | ..... | ..... | ..... |
| | | *Philippines Refinery | 20,000 bbls. | $23,000,000 | Planning | ..... | ..... | ..... | ..... |
| Shell (Philippines).... | Manila | Refinery | ..... | ..... | Negotiating | ..... | ..... | ..... | ..... |
| Standard-Vacuum.... | Bataan | Refinery | 21,000 bbls. | $33,500,000 | Planning | ..... | ..... | ..... | ..... |

* First appearance in tabulation. † Added capacity.

NOTE:
Armistead—George Armistead & Co.
Atlantic—Atlantic Ref. Co.
Badger Mfg.
Badger N. V.—Badger-Comprimo N. V.
Barnes—W. M. Barnes Co.
Bechtel—Bechtel Corp.
Beek—Henry C. Beek
Blaw-Knox—Blaw-Knox Co.
Braun—C. F. Braun Co.
Brown & Root—Brown & Root Construction Co.
Buckner—F. J. Buckner Corp.
Calif. Res.—California Research Corp.
Can. Kellogg—Canadian Kellogg Co.
Catalytic—Catalytic Construction Co.
Chemico—Chemical Construction Co.
Ch. Pro.—Chemical Process, Inc.
C. B. & I.—Chicago Bridge & Iron Co.
Chiyoda—Chiyoda Chemical Engineering & Construction Co., Ltd.
C. & I.—Chemical & Industrial Corp.
C. J. B. —Constructors John Brown, Ltd.
Consd. Eng.—Consolidated Engineering Company
C.T.I.P.—Compagnia Tecnica Industria Petroli
D & Z—Day & Zimmerman
Delta—Delta Engineering Corp.
Dresser—Dresser Engineering Corp.
Ebasco—Ebasco Services Inc.
E&A—Ehrhart & Associates, Inc.
Esso—Esso Research and Engineering Co.
Edeleanu—Edeleanu Gesellschaft M. B. H.
Etabadger S.A.—Etablissement Badger, S.A.
Ferguson—H. K. Ferguson Co.
Fish—The Fish Engineering Corp.
Fluor—Fluor Corp.
Ford, Bacon, Davis—Ford Bacon & Davis Construction Corp.
Foster Wheeler—Foster Wheeler Corp.
Gas Plant Constr.—Gasoline Plant Const Corp
Girdler—Girdler Construction Division, Chemetron Corp.
Girdler (Canada)—Girdler Corp. of Canada, Ltd.
Graver—Graver Construction Co.
Grebe & Doremus—Grebe & Doremus Process Co.
Gutte-Hutte—Gutehoffnungshuette
J.G.C.—Japan Gasoline Co.
Hedrick—Wyatt C. Hedrick Engineering Corp.
Hercules—Hercules Powder Co.
Hudson—Hudson Engineering Corp.
H&G—Humphreys & Glasgow, Ltd.
H.W.P.—Head Wrightson Process, Ltd.
Hydrocarbon—Hydrocarbon Research, Inc.
Hydro M—Hydrocarbon Mineralcel G.m.b.H.
Hydro E—Hydrocarbon Engineering S.A.R.L.
Kaiser—Kaiser Engineers
Kellogg—The M. W. Kellogg Co.
Kellogg P. A.—Kellogg Pan American
KIC—Kellogg International Corp.
Kidde Engrs.—Walter Kidde Engineers Southwest, Inc.
Kidde Constr.—Walter Kidde Constructors, Inc.
Koch—Koch Engineering Company
Koppers—Koppers Co., Inc.
Litwin—Litwin Engineering Co.
Lummus—The Lummus Co.
Lurgi—Lurgi G.m.b.H.
Masco—Masco Corp.
McKee—Arthur G. McKee Co.
Olsen—O. L. Olsen
Parsons—The Ralph M. Parsons Co.
Pet. Comb. & Eng. Co.—Petroleum Combustion & Engineering Co.
Petroco—Petroleum Construction Co.
Power Gas—Power Gas Corp., Ltd.
Pritchard—J. F. Pritchard Co.
Procon—Procon, Inc.
Quaker—Quaker Valley Constructors
Russell—Russell Engineering Corp.
Rust—Rust Engr. Co.
SBA—Soc. Belge de L'Azote et des Produits Chimiques du Marly
Scientific Design—Scientific Design Co.
Soc. Chimique—Societe Chimique de la Grande Paroisse
Southwestern—Southwestern Constr. Co.
Stearns-Roger—Stearns-Roger Mfg. Co.
S & W—Stone & Webster Engineering Corp., Chemical Division
S & W Canada Ltd.—Stone & Webster Canada Ltd.
S & W Ltd.
S & W Pty., Ltd.
Sweco—Southwestern Engineering Co.
Texas—Texas Engineers
Tellepsen—Tellepsen Petro-Chem Constructors
Treco—Refinery Engineering Co.
Tulsa—Tulsa Engineering Co.
Tulsams—Tulsams Builders
Uhde—Friedrich Uhde, G.m.b.H.
U.O.P.—Universal Oil Products Co.
Vulcan—Vulcan Engineering Div.

# *From Primary Element to Final Control Element...*



Through positioner and / or transducer...

To control valve

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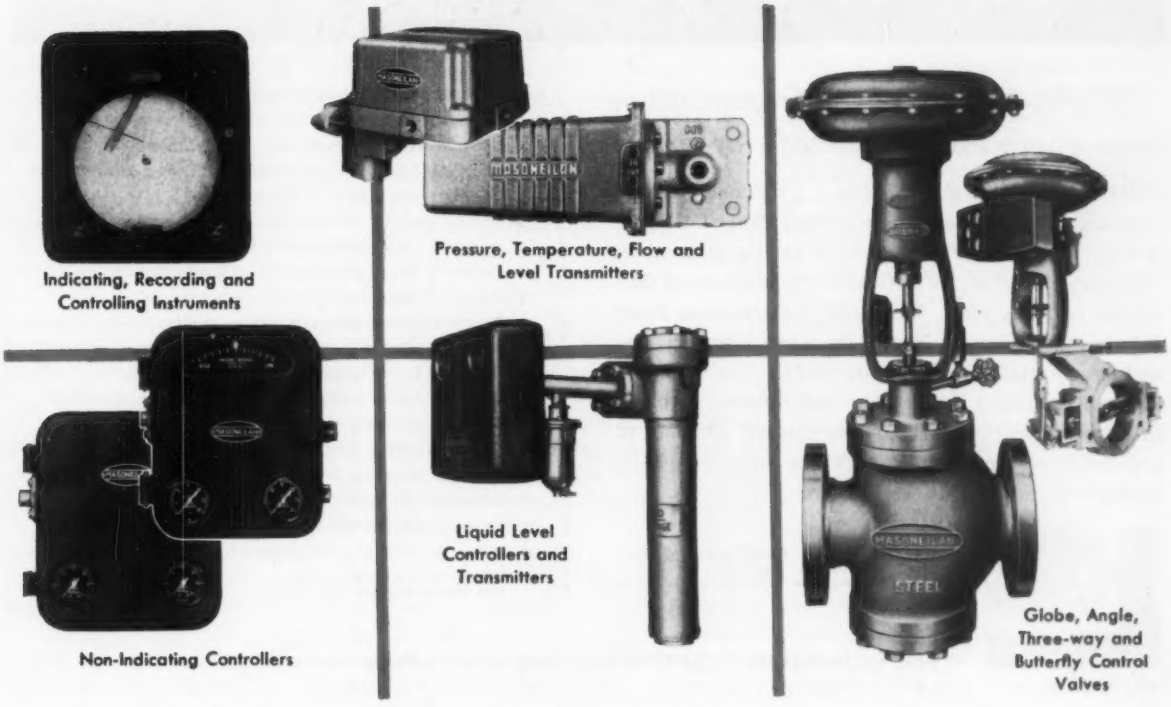


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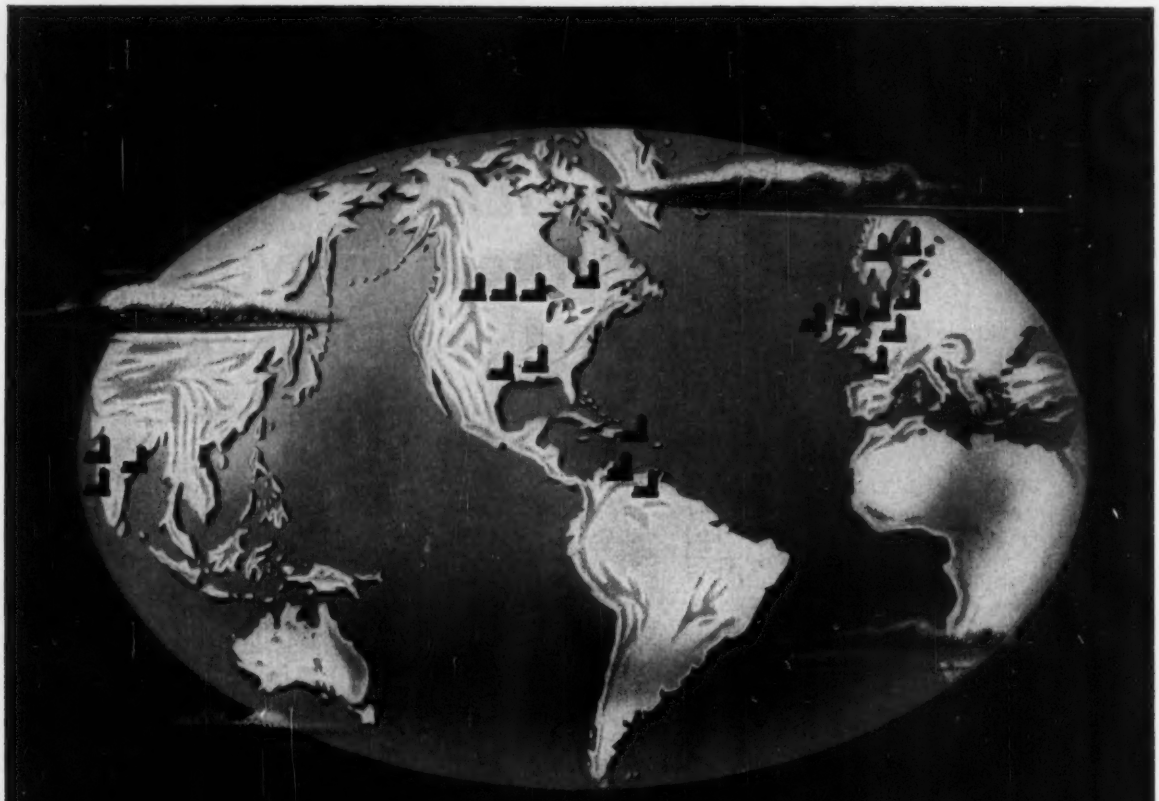

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As Management Sees It . . .

# Work Simplification Really Pays Off!

**"Work smarter, not harder" is the theme that is saving many dollars and boosting company morale**

**John F. Bishop and Carl Neisser**
Beckman Instruments, Inc., Systems Division
Anaheim, California

WORK SIMPLIFICATION is everybody's business.

Beckman Instrument's Systems division is adopting this philosophy in a comprehensive education program which goes all the way to the production line for new ways to reduce costs and improve manufacturing techniques.

Just in dollars saved, the return on the work simplification program is enough to warrant its continued existence. For instance, a recent 14-week course yielded cost reductions which will save an estimated $52,000 a year —on a training investment of about $1,000. But this is only part of the story. Work simplification is boosting morale by giving each employe a chance to express himself in tangible contributions to production operations. And, most important, work simplification is welding supervisors and employes into an efficient team of on-the-line methods experts dedicated to the principle, "There is always a better way."

The manufacture of electronic data systems is a complex business. The manufacturing engineers are confronted with a welter of production details that are always subject to the better way, by our basic work simp definition. The volume of opportunity for improvement demands additional brainpower, and Beckman is turning to the people who do the work for assistance.

**Keep Looking.** A two-pronged approach is used to teach the philosophy and potential of work simplification. It consists of a detailed course for supervisory personnel, based on their experience and aptitudes, and a shorter presentation of the same material for production line workers. The latter is designed to sell the benefits of work simp and to encourage employes to continually seek job improvement possibilities for evaluation and action by supervisors. The net result is a system for applying work simp techniques to a broad range of activities, tied to a method of converting ideas into money-saving improvements.

**What Is Taught.** The detailed program is based on principles evolved by Alan Mogenson, the director and founder of the Mogenson Lake Placid School in Work Simplification. The program follows the classic five-step work simplification formula—a logical system for anlyzing production jobs, developing improved methods and putting them into practice. The basic pattern:

1. Pick a job.
2. Get the facts.
3. Challenge each detail.
4. Develop the improved method.
5. Install the improved method.

As applied, the individual steps work like this:

*Pick a job:* a job which merits study can be determined by a number of criteria. Our principal barometers are high cost of operation, hazards to safety, employe discontent with operation and customer dissatisfaction with product feature.

*Get the facts:* the job is laid out in detail so it can be analyzed and evaluated. Tools for this step include flow process charts, right and left hand charts, man-machine charts and work distribution drawings.

*Challenge each detail:* the job and each detail are subjected to careful evaluation. The question "why?" is applied first to the whole operation and then to each of its parts. In this step, the order of the questioning is most important. The challenging step is a critical one. Techniques of inquiry, similar to those used by doctors, lawyers, newsmen and other professional people, are taught as a quick means to find the weaknesses in the way a job is being done.

*Develop the improved method:* this depends on the particular operation. The solution can be one of many—combination of functions, elimination of certain phases of the job, change of sequence, timing or operator.

*Install the improved method:* this is a selling job where consideration is not things but people who determine successful application of a new method. The "customers" range from management to production line workers and they all must be sold. The consultative approach is probably the best way to overcome resistance to change. Trainees are taught to consult the parties involved, ask their help and advice and enlist their support. The basic idea behind this approach is that most people are much more inclined to make a new method work if *they* have contributed *their* thinking to the project.

**Methods of Training.** Training methods are varied to sustain interest and communicate individual phases of instruction in the most effective way. Instructional techniques feature visual displays and "do it yourself" exercises designed to encourage the

all-important student participation. An essential element in the course is the assignment of work simp committees to in-plant production jobs. This yields practical experience under class supervision. At the same time it produces money-saving job improvements which invariably exceed training costs many times over.

The course concludes with a graduation banquet designed to salute outstanding accomplishment by work simp trainees and prepare the way for application of class-acquired skills to plant operations on a continuing basis.

The supervisors' work simp course covers 14 weeks, with weekly classes lasting an hour and a half. The production line employes' short course at present consists of six 30-minute sessions. Other company divisions have experimented with courses lasting from one to six months with the length of each meeting varied accordingly. The condensed course proves advantageous since graduates are put into the methods improvement business immediately. It also reduces the number of classroom set-ups of visual aids and props.

Materials used in the course range from movies and slides to opaque projectors, flannel boards and easels. Posters and signs are employed where they are most effective. Visual presentation is used wherever possible.

**Smarter and Better.** The course begins with a preview of the ground to be covered and the methods of training to be used. Emphasis is placed on the basic philosophy—"There's always a better way." Another maxim is introduced, the theme "Work Smarter —Not Harder." This slogan is stressed throughout the program.

The introduction to work simplification begins with the first in a series of "do it yourself" lessons. In this case it's the pegboard experiment. The pegboard represents a job project in which trainees try to evolve a simple, efficient method of placing wooden pins in holes. This exercise demonstrates the fundamental technical areas of work simp—motion economy, work place layout etc. As a joint, give-and-take effort by several class members at a time, it raises some of the human problems which will be encountered in the introduction of new methods of doing work.

The pegboard exercise leads directly to the establishment by class members of the operating definition of work simplification: "The organized use of common sense by everyone involved to find better and easier methods to do work."

**The Firm Resistance.** The human aspects of work simp are examined next. Trainees participate actively in the solution of a live problem, this time, the Case Role Play. One student plays the new supervisor, another the secretary who has been at her job a long time. The supervisor's assignment is to get the secretary to replace an outmoded filing system, which she originally designed, with a more efficient one. For instructional purposes, the secretary is designedly negative to the proposition.

The exercise bares two basic human problems which work simplification encounters: resistance to change and resentment of criticism. The supervisor tries to overcome these problems with the consultative approach. He asks the secretary to examine the proposed filing method and see if, *in her opinion,* it is feasible. He points out the merits of the new way over the old and asks the secretary for criticism and suggestion, based on *her* knowledge of the job. He encourages *her* to take a hand in instituting the change. He demonstrates how the change will make *her* job easier and more productive. He sells his idea on the basis that it will benefit both the secretary and the company.

The Case Role Play lesson is followed by a lecture and discussion on the economics of work simplification. The key point here is, "Everybody gains, including you," with the emphasis on "you." This builds enthusiasm for work simp and stresses its potential on the basis of what it will do for the individual. The principal theme states that production efficiencies strengthen the company and everyone in the company. The reasoning contends that reduced costs mean reduced prices which increase sales and jobs; more jobs mean more opportunity for the individual.

**Select With Care.** With the philosophy, purpose and potential of work simplification established, the course gets down to actual job improvement techniques. Steps 1 and 2 of the five-step pattern—pick a job, get the facts —are introduced. Fundamental criteria for singling out a job are explained. Beginning students are counselled against selecting jobs which they cannot handle. These could lead to failure and discouragement because of their complexity.

The flow process chart is now brought into the picture with a mild dodge to dramatize the importance of this basic work simplification tool. A situation is presented in which three girls are processing purchase orders, and class members are asked to suggest improvements in the operation. The instructor summarily rejects all suggestions, good or bad. The strategy is to show the need for an organized, logical approach to evaluation of an operation . . . this is accomplished by use of the flow process chart method rather than a random collection of suggestions.

The flow process chart (Figure 1) is presented in complete detail: explanations of the symbols which designate operations, transportations, inspections and delays; and a review of the chart layout which leads from job description to analysis to improvement. A movie is shown describing a typical office operation. Students detail the job on the flow process chart. Charts are then evaluated and corrected. An opaque projector flashes the chart on a screen as each additional step is made so the class can see what is happening.

As a final phase of the introductory session, students are assigned to make flow process charts of jobs around their homes. The detail which evolves from charting the commonest daily operations, from washing dishes to shaving, is extremely helpful in establishing the flow process chart as a valuable working tool.

**Three Men Best.** The next major step is formation of student committees and selection of actual in-plant work simp projects. The three-man committee is probably the most effective working unit. It's large enough to take on a significant project, yet small enough to keep all members busy and avoid delays stemming from excessive division of opinion.

Committees are given a relatively free hand in selection of projects. They are required only to clear a proposal before starting work to avoid duplication or selection of too ad-



vanced a project. Committees have a

the improved method to the individu-

ting finished items into stock. There

ANALYSIS: WHY? WHAT? WHERE? WHEN? WHO? HOW? — QUESTION EACH DETAIL

WORK SIMPLIFICATION PROGRAM

BECKMAN INSTRUMENTS, INC.

## FLOW PROCESS CHART

NO. 1

PAGE 1 OF 1

SUMMARY

| | PRESENT NO. | PRESENT TIME | PROPOSED NO. | PROPOSED TIME | DIFFERENCE NO. | DIFFERENCE TIME |
|---|---|---|---|---|---|---|
| ○ OPERATIONS | 15 | .367 | | | | |
| ⇨ TRANSPORTATIONS | 3 | .022 | | | | |
| □ INSPECTIONS | | | | | | |
| D DELAYS | | | | | | |
| ▽ STORAGES | | | | | | |
| DISTANCE TRAVELED | 50 FT. | | FT. | | FT. | |

JOB Assembly of Terminal Board Assembly

[X] MAN OR [ ] MATERIAL

CHART BEGINS Work bench; parts ready for assy.

CHART ENDS Work bench; assembly complete

CHARTED BY Committee #3 DATE 1-16-58

| | DETAILS OF (PRESENT / PROPOSED) METHOD | Operation | Transport | Inspection | Delay | Storage | Distance in Feet | Quantity | Time | Possibilities: Eliminate | Combine | Change: Sequence | Place | Person | Improve | NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Take parts to stake machine | ○ | ⇨ | □ | D | ▽ | 20 | | .008 | | | | | | | |
| 2 | Place terminals on board and stake | ● | ⇨ | □ | D | ▽ | | 16 | .067 | | | | | | | |
| 3 | Take parts to rivet machine | ○ | ⇨ | □ | D | ▽ | 10 | | .006 | | | | | | | |
| 4 | Rivet brackets to board | ● | ⇨ | □ | D | ▽ | | 2 | .008 | | | | | | | |
| 5 | Take parts to work bench | ○ | ⇨ | □ | D | ▽ | 20 | | .008 | | | | | | | |
| 6 | Assemble stand offs to brackets | ● | ⇨ | □ | D | ▽ | | 2 | .022 | | | | | | | |
| 7 | Wrap jumper leads to 11 terminals | ○ | ⇨ | □ | D | ▽ | | 6 | .067 | | | | | ✓ | | |
| 8 | Cut sleeving | ○ | ⇨ | □ | D | ▽ | | 2 | .006 | | | | | | | |
| 9 | Place sleeving on jumpers | ○ | ⇨ | □ | D | ▽ | | 2 | .004 | | | | | | | |
| 10 | Wrap jumper leads to 4 terminals | ○ | ⇨ | □ | D | ▽ | | 2 | .022 | | | | | ✓ | | |
| 11 | Hand form component leads with pliers | ○ | ⇨ | □ | D | ▽ | | 2 | .004 | | | | | ✓ | | |
| 12 | Wrap leads to terminals | ○ | ⇨ | □ | D | ▽ | | 2 | .010 | | | | | ✓ | | This operation repeated 7 times |
| 13 | Solder leads to terminals | ○ | ⇨ | □ | D | ▽ | | 2 | .007 | | | | | | | |
| 14 | Cut condenser leads to length | ○ | ⇨ | □ | D | ▽ | | 2 | .004 | | | | | | | |
| 15 | Cut sleeving | ○ | ⇨ | □ | D | ▽ | | 2 | .004 | | | | | | | |
| 16 | Place sleeving on leads | ○ | ⇨ | □ | D | ▽ | | 2 | .004 | | | | | | | |
| 17 | Wrap leads to terminals | ○ | ⇨ | □ | D | ▽ | | 2 | .004 | | | | | ✓ | | |
| 18 | Solder leads to terminals | ○ | ⇨ | □ | D | ▽ | | 2 | .008 | | | | | | | Assembly complete |
| 19 | | ○ | ⇨ | □ | D | ▽ | | | | | | | | | | |
| 20 | | ○ | ⇨ | □ | D | ▽ | | | | | | | | | | |
| 21 | | ○ | ⇨ | □ | D | ▽ | | | | | | | | | | |
| 22 | | ○ | ⇨ | □ | D | ▽ | | | | | | | | | | |
| 23 | | ○ | ⇨ | □ | D | ▽ | | | | | | | | | | |
| 24 | | ○ | ⇨ | □ | D | ▽ | | | | | | | | | | |

**FIGURE 1—Typical flow process chart permits layout of job in its various phases. This chart shows terminal board assembly before work simplification treatment. Symbols designate operation, transport, inspection, delay and storage. Directly to the right is list of alternate possibilities: eliminate job; combine it with another; change sequence, place, person; improve. These latter items can be checked for specific analysis after entire job is laid out. Summary block in upper left corner indicates time savings, a significant figure on repetitive operations. Filled-in symbols indicate those "Do" operations, essential functions as distinguished from secondary operations which constitute make-ready or put-away.**

vanced a project. Committees have a month to six weeks to complete projects.

With live committee projects underway, the last three steps of the five-step pattern are introduced. These are: challenging the job and its details, developing the improved method and installing the improved method.

**The Big "Why?"** In the challenging step, emphasis is placed on the importance of asking the critical "Why?" in its proper order. First, it is applied to the job as a whole, then to the most essential or "do" operations, and finally to the remaining operations. Unconvincing answers anywhere along the line immediately trigger consideration of improvement possibilities.

It works like this: the first question is, "What is done . . . and *why?*" This relates the specific job to its immediate environment. If the answer to "Why?" is not clear, students consider the possibility of eliminating the function entirely. If elimination is not feasible, the next question is, "Where is the job done . . . and *why?*"; followed by, "Who does the job . . . and *why?*"; and, "When is the job done . . . and *why?*" Weak or vague answers are regarded as signals to consider possible improvements in the operation.

Next, a logical series of possibilities is introduced: combination of functions, change of time sequence, change of place, change of person. Students are trained to instinctively look for a better way when any part or detail of a job appears to be weak.

At this stage, it's difficult to distinguish between Step 3—challenging the details, and Step 4—developing the improved method. These steps run together because an operation which fails to answer the challenge naturally warrants some logical move. Hence the two steps are presented as being virtually one.

The flow process chart is arranged graphically so improvement possibilities follow detail analysis. Thus the possibilities—eliminate a detail, combine functions, change sequence, etc. —can be considered once the over-all examination of the job has been completed.

**Convincing Others.** The final step, installation of the improved method, shifts from *things* to *people*. "Selling" the improved method to the individuals affected is stressed. Classroom dramas are used, and lessons are augmented by the actual experience of personnel who have introduced work simp improvements.

Here also is where the "Work Simplification Cost—Reduction Report" proves its value. This report (Figure 2) compares the present method of operation with the proposed method, then lists a comparison of the costs of the two. It also enables the group making the proposal to estimate the savings for each unit assembled and the net savings to the company the first year of operation. Actual cost reduction figures can be a big help in "selling" a new method.

Step 5 leads to a session on "Making the Improved Method Stick." The lesson is one in plain, simple follow-up. The material is principally the experience of people who have performed this function. There are no gimmicks or devices used. Straight discussion on human problems and their solutions is emphasized.

Committees report on their in-plant work simp projects as the course nears completion. Each committee takes half an hour to present its project. The rest of the class assumes the role of a board of directors which must be sold on the new idea.

The method of presentation is open and committees employ a variety of techniques. Some bring in an operator to demonstrate the old-versus-new method. Others prepare short movies or develop slide presentations. Competition for prizes generates interest, enthusiasm and ingenuity in the project presentation.

**Case History.** As a quick illustration of how work simplification has paid off, here's what happened when a student committee applied the formula to one production operation.

The committee decided to study the routing and assembly of core boards, printed circuit cards on which are mounted a number of solid state devices, such as transistors, diodes and other components. The core board was chosen because the great volume produced each year indicated that even a few economies could be multiplied into substantial cost reductions.

The flow process chart was employed to get the facts (Figure 1). Analysis revealed 141 separate operations, from removing wrappers to putting finished items into stock. There were numerous tests and inspections along the route. During assembly a board traveled 2,116 feet. There were 24 delays (dead time). Time of assembly was 4.187 hours.

**The Pay-Off.** The committee challenged all of these details and considered a variety of alternatives where answers to the question "Why?" were unsatisfactory. The end result was a substantially streamlined job. The 141 original operations were reduced to 66. Five wash operations were reduced to three and two 10-minute dry operations were eliminated. Test and inspection were assigned to one person and incorporated into the assembly set-up, cutting down travel distance and time for the individual boards. Transportations were reduced from 2,116 feet to 39 feet. Twenty-four delays were cut to 15. From a time standpoint, board assembly and routing were reduced from 4.187 hours per unit to 3.094 hours per unit.

Based on the number of these boards produced, the new method will save an estimated $20,000 a year. The $80 cost of new equipment was written off in nine hours of operation.

The substantial cost reduction was a big factor in "selling" the new idea and direct operators affected by the change were quick to accept it for two additional reasons. First, it meant getting more production for less effort. Second, the operators had played a part in working out the improved methods.

**Personal Application.** This generally is the Beckman/Systems work simplification program as it has evolved to the present. There is one more class, however; one devoted to personal efficiency. Here class members are taught to explore ways of applying work simp lessons to their own jobs. The approach is personal. One member details a typical day in his job while fellow students suggest improvements based on work simp course teachings. Personalizing the instruction gives it much deeper meaning.

**Diplomas and Prizes.** Graduation follows and it has a three-fold purpose:

1 To formally end the course.

2 To acknowledge the efforts of



winning committees and course grad- ricula, and reviews lessons to incor- taugh to discount such objections to

# WORK SIMPLIFICATION
## COST—REDUCTION REPORT

DESCRIPTION OF ITEM INVOLVED Terminal Board Assembly — FILE DEPT. NO. 362 — DATE 1-16-58
DEPT. Sub Assembly — PRODUCT
OPERATION Assembly
OBJECT OF ANALYSIS Reduce Cost

**COMPARISON**

| PRESENT METHOD | PROPOSED METHOD |
|---|---|
| MACHINE Staking and Rivit Machines | MACHINE |
| TOOLS Pliers, Soldering Iron and Diagonal Cutters | TOOLS Soldering Iron |
| DESCRIPTION Stake terminals to boards, attach brackets, assemble components to boards. | DESCRIPTION Assemble components to commercial terminal boards. |

| COST OF OPERATIONS INVOLVED | | $ PER | COST OF OPERATIONS INVOLVED | | $ PER |
|---|---|---|---|---|---|
| LABOR | | Avg. Assy. 1.89 | LABOR | | Avg. Assy. .54 |
| MATERIALS | Board | 1.47 | MATERIALS | Board | .51 |
| | Terminals | .32 | | Stand Offs | .24 |
| | Brackets | 2.66 | | | |
| MISC. | Stand Offs | 1.58 | MISC. | | |
| TOTAL OF ABOVE ITEMS | | $7.92 | TOTAL OF ABOVE ITEMS | | $1.29 |

ESTIMATE OF SAVING
SAVING WITH PROPOSED CHANGE ($7.92 − $1.29 ) EQUALS $6.63 PER Avg. Assy.
PROBABLE YEARLY REQUIREMENTS, Equal to 180 avg. assy ESTIMATED BY Manufacturing Engr.
ESTIMATED SAVINGS PER YEAR (BASED ON 180 Avg. Assemblies PER YEAR) $ 1193.40

| ESTIMATED COST OF CHANGE | | | |
|---|---|---|---|
| DESIGN | $ 102.50 | EST. BY | Mfg. Engrg. |
| EQUIPMENT | $ 0 | " " | |
| INSTALLATION | $ 0 | " " | |
| | $ | " " | |
| | $ | " " | |
| | $ | " " | |
| TOTAL COST OF CHANGE | $ 102.50 | | |

PROBABLE SAVINGS PER YEAR $
LESS TOTAL COST OF CHANGE $ 102.50
NET SAVINGS FIRST YEAR $ 1090.90
NEW METHOD WOULD PAY FOR ITSELF IN .1 MONTHS.
NOTE

SUGGESTED BY B. Knerr
REPORT PREPARED BY Committee #3

CC TO

ATTACHED ARE
SHEETS DRAWINGS
SHEETS PRINTS
SHEETS DETAILS

DATE
FIRST CONSIDERED 12/13 EXPEN. APPR. DATE
INVESTGN. STARTED Same INSTALLED
REPT. SUBMITTED 1/20/58 FINAL REPT.

FIGURE 2—Typical "Work Simplification Cost-Reduction" helps "sell" new ideas. Report compares present and proposed methods of operation, then compares cost of each. One section gives estimates on net savings the first year.

winning committees and course graduates.

3 To encourage the continued application of course lessons to full-time operations. The second point is particularly important. Recognition of outstanding performance is a cherished reward which stimulates enthusiasm for the program and injects productive competition.

We generally stage a graduation banquet. Graduates attend as guests of the company. Diplomas go to all students. Prizes are awarded for winning committee projects, based on dollar savings, degree of committee member participation and application of work simplification principles. Prizes range from transistor radios to cigarette lighters. Project winners are listed in the company publication and in stories released to local newspapers.

To sustain the program, we've set up a work simplification advisory board consisting of factory supervisors and the division production manager. The board's responsibilities include screening proposed new projects, advising on the execution of projects, and assisting on follow-up operations. The board determines when it is necessary to begin additional training programs. It arranges classes and curricula, and reviews lessons to incorporate improved work simp techniques.

**Interest is Paramount.** In reviewing the program, several features stand out. Eager student participation is perhaps the element most essential to success. Participation generates enthusiasm for the subject matter, and serves as a challenge for stimulating productive effort. Committee projects with heavy emphasis on "do it yourself" yield the all-important sense of personal accomplishment.

The course must be interesting. Student participation certainly heightens the interest factor, but presentation of material also is very important. Material must be tailored for the specific audience. This means keeping it non-technical enough for good comprehension without simplifying it to the point of boredom. Demonstrations and visual displays are better interest holders than straight lectures, therefore lecture time is kept to a minimum. Lecturers should be schooled to lead classes without dominating them. This encourages maximum student participation.

**Use Stimulators.** It is also important to create the proper climate. Therefore, special care is taken to relate work simp to the interest and welfare of the individual student, emphasizing the "Work Smarter—Not Harder" theme. To whet curiosity and interest, we launched initial courses with a campaign featuring large green traffic lights spotted around the plant, cryptic signs, posters and other devices. These were explained at the first meeting.

The traffic light is an essential device. The green light symbolizes the open mind, the readiness to accept change and to be continually on the lookout for job improvements. Positive thinking is another way of saying it. The red light symbolizes the reverse of this condition. In class sessions, we use a little electric traffic light to regulate discussion. When a student is following a positive approach, he gets the green light; when he takes a negative tack he gets the red light.

Elimination of negative thinking is a prime objective in selling the basic theme of the program—"There is always a better way." Students are taugh to discount such objections to change as, "We tried that before and it didn't work." "The problem isn't in your area, so don't worry about it." Slogans are useful in creating the proper climate—"The fun of living is trying to make something better," or in putting across a lesson effectively—"Why the hell out of everything."

**Top to Bottom.** Another vital element in the success of any work simplification program is *active, personal* top management support. Management helps sell the program by participating actively in class sessions and following up with supervisors on specific projects. Management also demonstrates genuine interest in a program by extending personal praise when the occasion demands it, an important complement to the formal recognition given at graduation time.

Management also insures success of a work simp program by giving it priority status which guarantees immunity from inevitable crash programs which otherwise could usurp time earmarked for training purposes. All this implies, of course, that management must be sold on work simplification to start with. Unless management is prepared to support work simp with time and money, the program will languish.

**Constant Improvement.** It is important to assign a person the task of expediting work simp programs and to equip him to carry out this function. A program of any consequence cannot be treated as a stepchild. It takes time to arrange the many details and presentations and keep abreast of new developments in work simp technology. Our divisional advisory board works with a company work simp coordinator who watches progress in all divisions. We also continue to seek the help of outside counsel, universities and other companies in improving our work simp program. Outside experts can contribute materially toward making the program better.

Finally, we make it a point to extend proper recognition for work simp accomplishment. Recognition builds morale and enhances the spirit of teamwork in a mutually beneficial endeavor. And recognition stimulates respect and enthusiasm for work simplification and its application as a tool for building a more efficient production operation. # #

## About the Authors

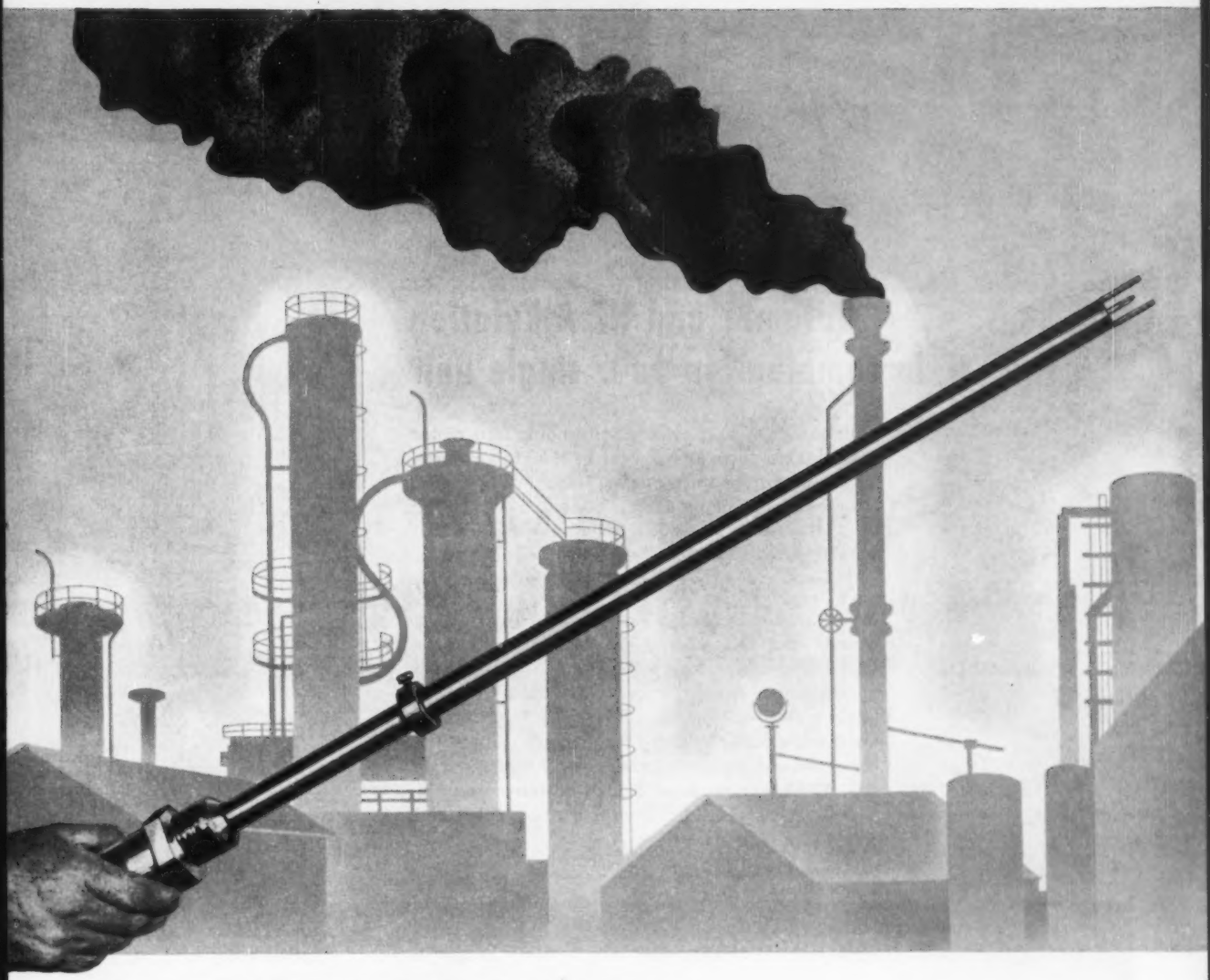
Neisser

Bishop

**Carl Neisser** is manufacturing manager for Beckman Instruments, Inc.'s Systems division, Anaheim, Calif. He received a B.S. degree from Yale University and took an advanced management course from the U.C.L.A. Graduate School of Business.

**John F. Bishop** is manager of the Systems division, Beckman Instruments, Inc., Anaheim, Calif. He received a B.S. degree in engineering from the University of California in 1945, and a M.B.A. degree from Harvard University in 1948.

# Thousands going up the stack?



## Reduce Flaring Losses
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### with the "Anemotherm" Probe-Type Gas Flow Meter

You can stop profits from going up the flare stack with the new "Anemotherm" *Probe-Type* Gas Flow Meter. This *electronic, stainless steel* instrument quickly locates points of loss . . . accurately measures gas flow from 10 to 15,000 FPM with a scale range of 500 to 1. Refineries report savings of thousands of dollars per day.

The new "Anemotherm" Gas Flow Meter offers many exclusive features. Sixteen probe meters can be connected to one strip recorder so that flow in sixteen process lines can be observed and recorded by one instrument. The probe is self-compensating for ambient temperature and can be used in gas streams to 300°F. The probe has fast response, is corrosion resistant and streamlined. Accuracy is ± 5% of meter reading. The "Anemotherm" Gas Flow Meter is easy to install and easy to clean.

Look into the money-saving accuracy and efficiency of the "Anemotherm" Gas Flow Meter. For complete engineering data send for Technical Bulletin 5000.

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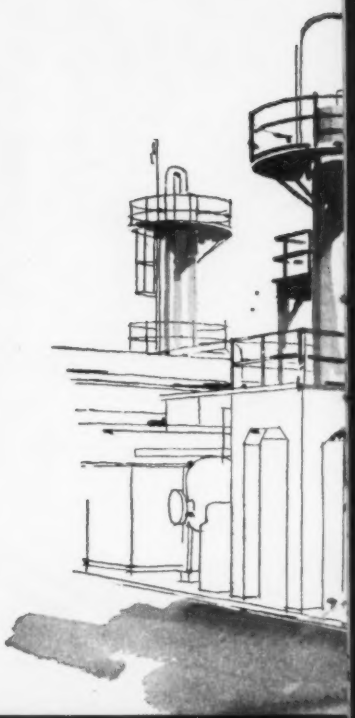
# BUTAMER*

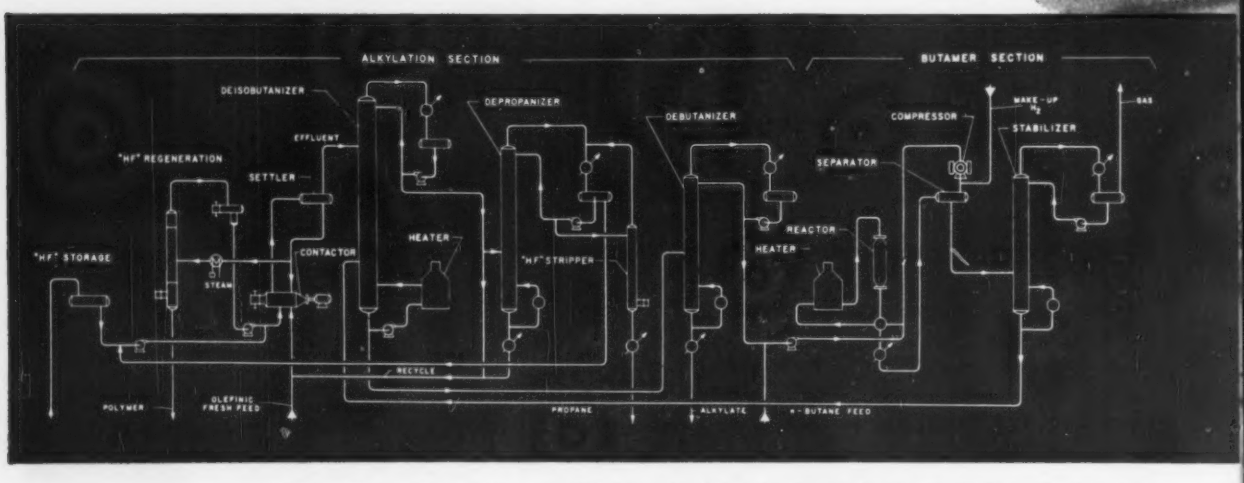
## The most practical method for producing alkylate: Butamer and HF Alkylation in combination as a single unit

Increasing use of alkylate for blending into motor fuels makes these two up-to-the-minute processes highly important to petroleum refiners. Butamer is a new process for producing isobutane . . . "HF" Alkylation is an efficient, economical process which combines isobutane with olefins to produce alkylate, much in demand today as a motor fuel component.

With the advent of high compression ratio engines, usually starting at 9.5:1, motor fuel, especially those deficient in isoparaffins, have been associated with an unusual engine noise called "rumble." Further study reveals this rumble can be eliminated through the use of a better balanced fuel, namely using a fuel composed of a greater volume percentage of isoparaffins. Alkylation produces a high octane isoparaffin that also has good sensitivity, ignition point and combustion characteristics.

*Trademark






*More Than Forty Years Of Leadership In Petroleum Refining Technology*



For more data on advertised products, use Readers' Service Cards, last page.

# HF Alkylation

***Butamer***—Heart of this process is a noncorrosive, stable and rugged platinum-containing catalyst especially developed by UOP. Capable of operating at relatively low temperatures, its use assures a sufficiently high concentration of isobutane in the reactor effluent to eliminate excessive recycle of normal butane.

Operating under hydrogen pressure, with low hydrogen-to-charge ratio, the high catalyst activity results in economical liquid hourly space velocities, thus requiring only a modest catalyst inventory. The mild operating conditions further assure minimum loss to by-products.

***HF Alkylation***—"HF" Alkylation is a catalytic process which combines olefins such as propylene, butylenes, and amylenes with isoparaffins (usually isobutane) to form a mixture of branched chain hydrocarbons of higher molecular weight known as alkylate for aviation and motor fuel.

These two processes are readily and economically integrated. Together, they form the ideal, most practical method for producing alkylate.

Write for detailed information. Ask also about other UOP refining and petrochemical processes, available to refiners everywhere, for improving operating efficiency and producing better and more profitable petroleum products.

UOP

**UNIVERSAL OIL PRODUCTS COMPANY**
**30 Algonquin Road, Des Plaines, Illinois, U.S.A.**



For more data on advertised products, use Readers' Service Cards, last page.

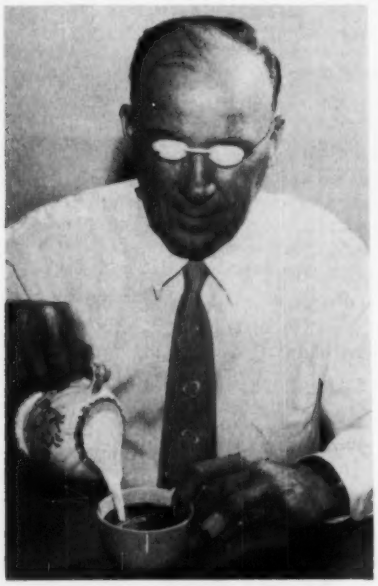
Charles A. Stogoski attempts the difficult job of putting tooth powder on a tooth brush by guesswork.

David J. Joyce, Jr., relies on his fingers to indentify different swatches of material.

Mrs. Elizabeth Fritz tries her hand at dialing a phone number with vision blocked off.

# 'Blind' Supervisors Learn Safety Fast

**Howard F. Kempsell**
Esso Research and Engineering Co., Linden, N. J.



Pouring the right amount of cream into a cup of coffee blindfolded takes practice, Anthony F. Mastrocitch found.

TO DRAMATIZE the penalty of accidental eye injuries, Esso Research and Engineering Co. has launched a novel safety program for 1,000 of its 3,000 employes in Linden, N.J.

Employes, meeting in small groups, are blinded by masks and asked to perform simple, everyday activities. Without the use of their eyes, they try to dial a telephone number . . . light a cigarette . . . spread tooth powder on a tooth brush . . . identify swatches of material.

They quickly learn that vision can never be taken for granted.

Primary purpose of the program is to encourage full use of safety glasses or goggles when they're called for on the job.

Last year 24 company employes suffered accidental eye injuries (none leading to blindness).

This is not a bad record. None of these injuries involved permanent eye impairment. But Esso Research and Engineering would like to push the figure down to zero if possible.

This "blind" program recently started ought to help a lot. It's impressing people that vision is priceless. You might say they're reminded all over again that you can't use false eyes like you can false teeth.

The simulated blindness program is based on special kits prepared by the National Foremen's Institute. Each kit contains a mask plus the material needed to perform the prescribed tasks blindfolded (i.e., tooth powder, tooth brush, swatches of material, etc.). A phonograph record provided by the National Foremen's Institute works a sermon on eyesight protection into the instructions on how to use the kits.

Members of Esso Research's company-wide Central Safety committee tried the unique program out on themselves before adopting it. The first group of employes to "go blind" in the interest of safety were 15 supervisors in the firm's Service division.

Said one, after removing the blindfold he'd worn for 30 minutes:

"I've never felt so helpless!"

Blindfolded group sits around conference table, listening to phonograph record which directs correct use of safety kits. Observing program is M. D. Haworth, head of firm's Service division.

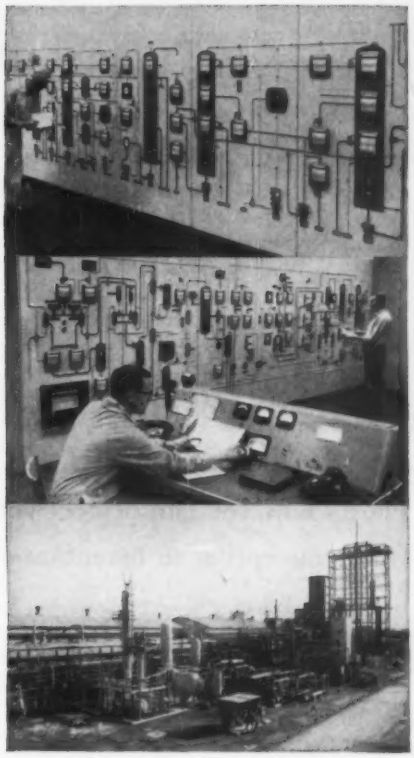
Thomas E. Rush, Jr., right, chairman of the safety committee of Esso Research's Service division, and Author Howard F. Kempsell review contents of National Foreman's Institute safety kits.

William F. Stevens had trouble lighting a cigarette without the use of his eyes. Stephen R. Scheckler stands by to see that he doesn't burn himself.

## About the Author

**Howard F. Kempsell** is an engineer with Esso Research and Engineering Co., Linden, N.J., where he coordinates company safety activities and serves as chairman of the Central Safety committee and Disaster Control committee. He received a B.S. degree in civil engineering from Virginia Military Institute—then served two years as an equipment inspection engineer with Esso Standard Oil Co., 1½ years as a U.S. Air Force ground safety director, and four years as an assistant to the refinery safety supervisor at Esso Standard Oil Co. Kempsell has held his present position since July, 1957.

FOXBORO
REG. U.S. PAT. OFF.



## Sun Oil Company reports:

# "TWO YEARS OPERATION— AND WE HAVEN'T HAD A CONSOTROL* OFF THE PANEL YET"

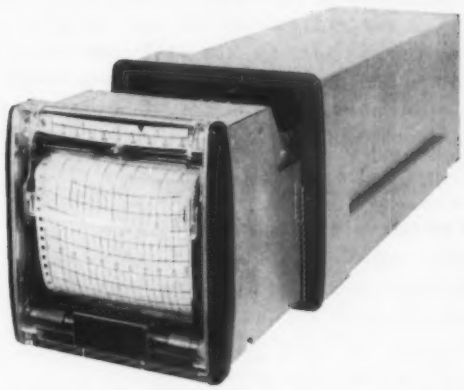
Not only by their unvarying dependability of control, but also through unusual economy of maintenance, Foxboro pneumatic Consotrol Recording Control Stations have proved a profitable investment for Sun Oil Company at Marcus Hook, Penna.

Over two years ago, 129 pneumatic Consotrol instruments were installed as complete instrumentation for the control rooms of the ammonia plant and the Houdriflow catalytic cracking unit in this modern Sun Oil refinery. In continuous operation ever since, not a single Consotrol Recorder or Controller has yet needed recalibration or realignment!

Add to this the fact that Consotrol Recorders need replacement of their full-scale, 4-inch strip charts as infrequently as once a month — re-inking only twice a year — and it's easy to understand why Sun Oil men at Marcus Hook are more than satisfied with Consotrol equipment.

Get the full story of these ultra-dependable Recording-Controllers before you design your next control system. Write for Consotrol Bulletin 13-18. **The Foxboro Company, 741 Neponset Avenue, Foxboro, Massachusetts.**

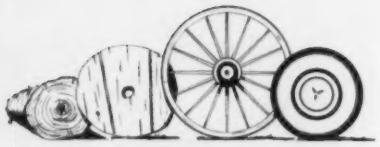
*Reg. U. S. Pat. Off.



Each pneumatic Consotrol Control Station consists of a Recorder with M/58 Controller integrally mounted at rear. Complete station pulls out from front of panel, as shown above.

**SHOWN OPPOSITE** is part of graphic control panel for cracking unit at Sun Oil Company, Marcus Hook, Penna. All panel instruments were supplied by Foxboro.

## CONSOTROL INSTRUMENTS



*How to Invent: Part 6*

# Patent Laws You Should Know

**Here's how you can protect your ideas all along the line—from conception to invention**

**Forrest E. Gilmore**
Independence, Kansas

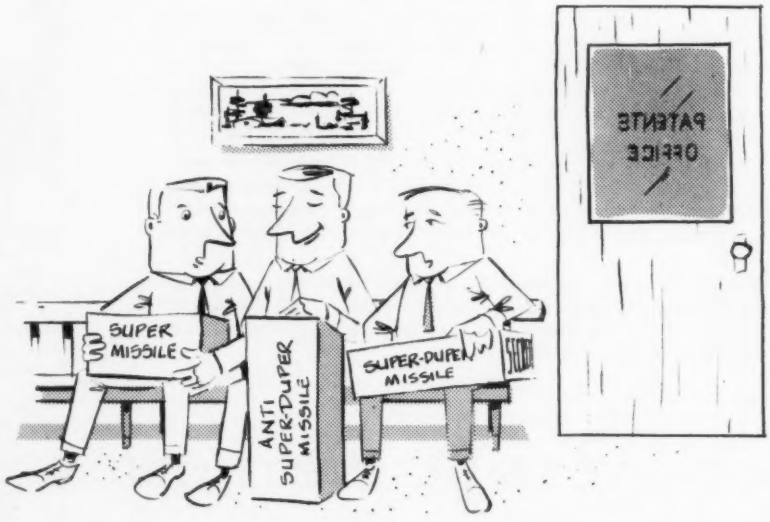
THIS ARTICLE will give you only the practical information you need in order to understand what can be patented, how to go about protecting your invention before filing for a patent and how to obtain a patent. Probably most engineers who read this are employed or will be employed by some large corporation which has its own patent attorneys and thus relieves its employes of the necessity to know much about patent law and procedure. However, it is always advantageous to the would-be-inventor to know basic law and procedure in obtaining a patent although it is much more important if the inventor is inventing for himself independent of an organization. For easy reference, this article is broken down into headings indicating what is contained under each.

## WHAT IS PATENTABLE?

**Constitutional and Basic Laws.** The constitution of the U. S. gives Congress power "to promote the progress of science and the useful arts by securing for limited times to authors and inventors, the exclusive right to their respective writings and discoveries."

The Federal statutes provide that "any person who has invented or discovered any new and useful art, machine, manufacture, or composition of matter, or any new and useful improvement thereof, or who has invented or discovered and asexually reproduced any distinct and new variety of plant other than a tuber-propagated plant, not known or used by others in this country, before his invention or discovery thereof, and not patented or described in any printed publication in this or any foreign country, before his invention or discovery thereof, or more than one year prior to his application, and not in public use or on sale in this country for more than one year prior to his application, unless the same is proved to have been abandoned, may, upon payment of the fees required by law, and other due proceeding had obtain a patent therefore."

**American Patent System.** A court decision frequently referred to by patent attorneys stated: "Invention consists of the conception of a function and the selection of



means whereby the function can be operatively carried out." Patent laws, like many other laws, have been amplified and made more specific by many court decisions, and have been revised by new laws and procedures set up by rules of the Patent Commissioners.

All these laws, court decisions and rules of the Patent Commissioners comprise what is commonly referred to as the American Patent system. This system is, without doubt, the best patent system in the world and has contributed greatly to our present leading technological and industrial position.

**What is Patentable? 1.** The invention must possess novelty which is a Patent office term meaning that it is new.

**2.** It must be useful and operable i.e., have a fair degree of practicability and be able to do what is was designed to do.

**3.** It must not be injurious to public morals or health.

**4.** Natural laws cannot be patented, however, a practical device to use them may.

**5.** Combinations of elements to produce some entirely new effect may be patentable but mere aggregations of these elements are not.

**6.** Mere extension of an application, such as mixing oils in place of concrete, is not invention.

**7.** Printed matter, methods of doing business and improvements in devices which are the result of mere mechanical skill are not patentable; the invention must not be obvious to one skilled in the art at the time the invention was made.

**8.** New compositions of matter are patentable.

**9.** New use of a known process, machine, manufacture, composition of matter, or material is patentable.

**10.** The use of a certain material in place of another in a device is not usually patentable but can be when the result is different from that normally expected.

**11.** Design patents can be obtained on any new, original, and ornamental design for an article of manufacture.

**12.** Plant patents can be obtained for certain asexually reproduced plants subject to limitations stated in the patent laws.

## OBTAINING A PATENT

**Who Can Get One.** The inventor must sign the application but if he refuses or cannot be located, a party to whom he agreed in writing to assign the invention may file the application. In the case of joint inventors, where one refuses to sign or cannot be located, the others may sign and the patent will be issued to them but it will be subject to the rights of the omitted inventor just as through he had signed.

When the name of an inventor is omitted by mistake it can be added. A mistake in inventorship of a patent may be corrected even after the patent is in court in litigation.

**The Patent Application.** The Rules of Practice of the U. S. Patent Office, can be obtained from the Superintendent of Documents, Government Printing Office, Washington, D.C. for 40 cents. It gives the following information:

"The preparation of an application is a highly complex proceeding and generally can not be conducted properly except by an attorney or agent trained in this specialized practice. The inventor, therefore, is advised to employ a patent attorney or agent who is registered, as the value of a patent depends upon skillful preparation of the specification and claims.

"A complete application comprises (1) the first fee of $30 plus an additional dollar for each claim in excess of 20, (2) a petition, (3) specification and claims, (4) an oath, and (5) a drawing when needed. The petition must be addressed to the Commissioner of Patents and must state the name, residence, and post office address of the inventor, give the title of the invention, and must be signed by the inventor. The following order of arrangement should be observed in framing the specification:"

- Preamble stating the name and residence of the applicant and the title of the invention.
- General statement of the object and nature of the invention.
- Brief description of the several views of the drawings (if the invention admits of such illustration).
- Detailed description.
- Claim or claims.
- Signature of applicant.

The two principal features of the patent application that the inventor needs to keep in mind are: (1) That the specification is a written description of the invention and how it is made and used, and is in full, clear, concise, and exact terms as to enable any skilled person to understand it, and (2) that the patent which results gives the inventor only the invention claimed in the claims however, the claims can be changed by amendment after the application is filed but cannot be enlarged beyond the disclosure of the specification. The claims finally allowed constitute the boundary of the patent.

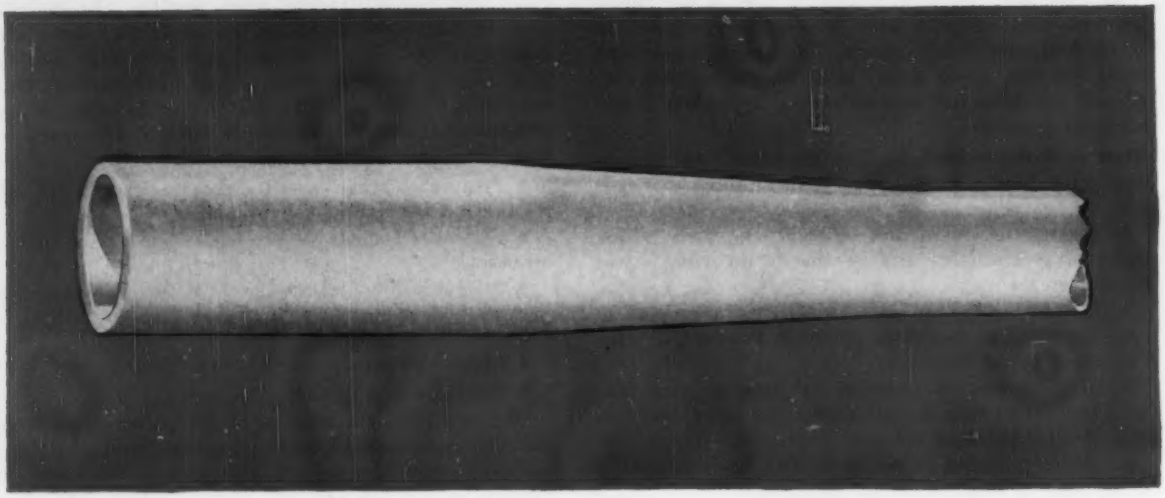
**Patent Application Handling.** Upon receipt of patent application, the Patent Office classifies it, gives it a serial number and notifies the inventor. The application must then await its turn before it gets attention from the Patent Office examiners. This generally takes from six months to one year, depending on how busy the examiners are in the department in which the application is to be examined.

The examiner carefully considers the patent claims and searches the Patent Office to see that a similar device has not been patented before. Nearly always, all the claims are rejected on some prior art in first official action and all adverse data is brought to the attention of the inventor.

To the uninitiated this first rejection of most of or all of the claims and the citing of references to substantiate the rejection, is rather upsetting. To the inventor the references cited may seem so unlike the invention that the citing of them is utterly ridiculous or they may be readily combined to constitute the invention once his invention is disclosed but otherwise unlikely. The examiner is probably just shifting the burden of the work necessary to ferret out the new in the invention over prior art.

The inventor's patent attorney will know how to handle the matter. He will prepare an amendment changing claims wherever advisable, and arguing for the retention of those which he can show are not covered by prior art cited in the references. He has six months from the date of the Patent Office action in which to file an amendment. The Patent Office will usually reply to the amendment in about six months.

# Put strength where it counts!



# New Reynolds Aluminum

...eliminates over-design...gives more pipe strength per dollar

Now... from Reynolds Aluminum... a major advance in piping design. It's Reynolds new Heavy-End-Pipe®—pipe designed to put strength where strength is needed—at the *joint*. And it eliminates excess metal in the pipe body, to save up to 27% in piping costs.

With Reynolds new Heavy-End-Pipe, you no longer have to over-design your system to allow for reduced joint strength. This tough, lightweight aluminum pipe gives you more usable pipe strength, cuts your piping costs, simplifies your design job.

You design to uniform strength all through with Reynolds Heavy-End-Pipe, and pay only for the metal required. No waste metal, no waste costs, no waste weight. Compensation for joint efficiency is built into the pipe.

Reynolds Heavy-End-Pipe is available in Schedule 40 equivalent and Schedule 80 equivalent sizes, in 40 ft. lengths. Ends have the same diameter and thickness as standard sizes, so standard fittings can be used. Also, Heavy-End-Pipe can be used interchangeably with other standard pipe.

Like all Reynolds Aluminum Pipe, H-E Pipe® costs much less than other corrosion resistant piping with equal performance. It won't contaminate the fluids it handles; it resists corrosion by most process liquids. More and more companies are changing to aluminum piping because it is lightweight, non-sparking, easily formed, joined, welded.

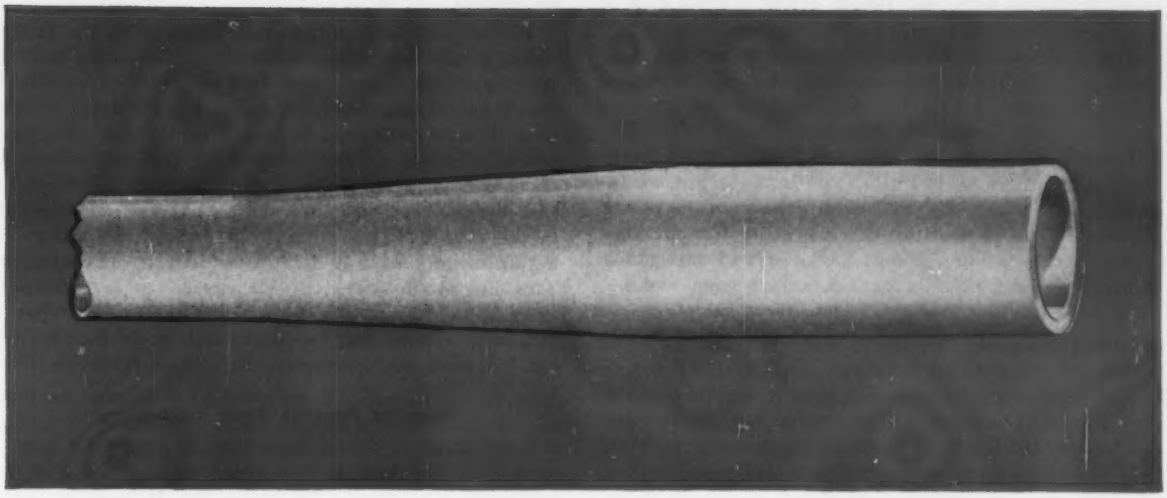
Be sure to consider the cost-cutting, design-simplifying benefits of Reynolds H-E Pipe® in your next system. Get full details from your local Reynolds branch office, or write *Reynolds Metals Company, P.O. Box 2346-CT, Richmond 18, Virginia.*




There is no need here to go into all the details of sub-

Without patent protection, most of the inventions now

# Save up to 27% in piping costs!



## HEAVY-END-PIPE®

... cuts weight... simplifies design... strengthens joints

**REYNOLDS HEAVY-END-PIPE® DESIGN DATA**

**Schedule 80 Equivalent**

| Nominal Size | Major (Heavy End) O. D. | Major (Heavy End) Wall | Heavy End I. D. | Heavy(1) End Length | Minor Body O. D. | Minor Body Wall | Minor Body I. D. | Average(2) Weight Per Ft. |
|---|---|---|---|---|---|---|---|---|
| Inches | Inches | Inches | Inches | Inches | Inches | Inches | Inches | Pounds |
| 3 | 3.500 | .300 | 2.900 | 10 | 3.150 | .200 | 2.750 | 2.29 |
| 3½ | 4.000 | .318 | 3.364 | 10 | 3.642 | .214 | 3.214 | 2.84 |
| 4 | 4.500 | .337 | 3.826 | 11 | 4.140 | .232 | 3.676 | 3.57 |
| 5 | 5.563 | .375 | 4.813 | 11 | 5.185 | .261 | 4.663 | 4.98 |
| 6 | 6.625 | .432 | 5.761 | 12 | 6.217 | .303 | 5.611 | 6.95 |
| 8 | 8.625 | .500 | 7.625 | 12 | 8.183 | .354 | 7.475 | 10.68 |
| 10 | 10.750 | .593 | 9.564 | 13 | 10.260 | .423 | 9.414 | 15.65 |

(1) Length of heavy end wall thickness exclusive of transition zone
(2) Based on 40 ft. length

**Schedule 40 Equivalent**

| Nominal Size | Major (Heavy End) O. D. | Major (Heavy End) Wall | Heavy End I. D. | Heavy(1) End Length | Minor Body O. D. | Minor Body Wall | Minor Body I. D. | Average(2) Weight Per Ft. |
|---|---|---|---|---|---|---|---|---|
| Inches | Inches | Inches | Inches | Inches | Inches | Inches | Inches | Pounds |
| 3 | 3.500 | .216 | 3.068 | 10 | 3.214 | .148 | 2.918 | 1.76 |
| 3½ | 4.000 | .226 | 3.548 | 10 | 3.724 | .163 | 3.398 | 2.22 |
| 4 | 4.500 | .237 | 4.026 | 11 | 4.218 | .171 | 3.876 | 2.64 |
| 5 | 5.563 | .258 | 5.047 | 11 | 5.259 | .181 | 4.897 | 3.53 |
| 6 | 6.625 | .280 | 6.065 | 12 | 6.311 | .198 | 5.915 | 4.66 |
| 8 | 8.625 | .322 | 7.981 | 12 | 8.291 | .230 | 7.831 | 7.12 |
| 10 | 10.750 | .365 | 10.020 | 13 | 10.388 | .259 | 9.870 | 10.16 |

(1) Length of heavy end wall thickness exclusive of transition zone
(2) Based on 40 ft. length

| Nominal Size | 6061-T6, 6062-T6 Alloy | | | | 6063-T6 Alloy | | | |
|---|---|---|---|---|---|---|---|---|
| | Ultimate Bursting Pressures | Working Pressures Factor of Safety 3 | 4 | 5 | Ultimate Bursting Pressure | Working Pressures Factor of Safety 3 | 4 | 5 |
| Inches | psi | psi | psi | psi | psi | psi | psi | psi |
| 3 | 5150 | 1720 | 1290 | 1030 | 3680 | 1220 | 920 | 740 |
| 3½ | 4750 | 1580 | 1190 | 950 | 3400 | 1130 | 850 | 680 |
| 4 | 4460 | 1490 | 1110 | 890 | 3180 | 1060 | 790 | 640 |
| 5 | 3990 | 1330 | 1000 | 800 | 2850 | 950 | 710 | 570 |
| 6 | 3850 | 1280 | 960 | 770 | 2760 | 920 | 690 | 550 |
| 8 | 3410 | 1140 | 850 | 680 | 2430 | 810 | 610 | 490 |
| 10 | 3240 | 1080 | 810 | 650 | 2310 | 770 | 580 | 460 |

| Nominal Size | 6061-T6, 6062-T6 Alloy | | | | 6063-T6 Alloy | | | |
|---|---|---|---|---|---|---|---|---|
| | Ultimate Bursting Pressures | Working Pressures Factor of Safety 3 | 4 | 5 | Ultimate Bursting Pressures | Working Pressures Factor of Safety 3 | 4 | 5 |
| Inches | psi | psi | psi | psi | psi | psi | psi | psi |
| 3 | 3640 | 1210 | 910 | 710 | 2600 | 860 | 650 | 520 |
| 3½ | 3450 | 1150 | 860 | 690 | 2365 | 790 | 590 | 470 |
| 4 | 3070 | 1020 | 760 | 610 | 2195 | 730 | 550 | 440 |
| 5 | 2690 | 890 | 670 | 540 | 1925 | 640 | 480 | 380 |
| 6 | 2450 | 810 | 610 | 490 | 1750 | 580 | 430 | 350 |
| 8 | 2160 | 720 | 540 | 430 | 1540 | 510 | 380 | 310 |
| 10 | 1950 | 650 | 480 | 390 | 1395 | 460 | 350 | 280 |

# REYNOLDS ALUMINUM

Watch Reynolds new TV shows—"WALT DISNEY PRESENTS" and "ALL-STAR GOLF"—every week on ABC-TV.

The Finest Products Made with Aluminum are made with REYNOLDS ALUMINUM

There is no need here to go into all the details of subsequent actions and amendments, possible interviews and appeals. If all goes reasonably well the inventor should get his patent about two years from date of filing. Once the Patent Office and the inventor come to an agreement over the claims to be allowed, a notice of allowance of the patent is issued. It calls for the final payment of $30 within six months. Within one month after this final fee is paid, the patent is published and a copy is mailed to the inventor.

### Patent Meaning

Previous to the Bryson Bill going into effect on January 1, 1953, the patent right was stated to be the "exclusive right to make, use and vend" the product of the invention. The Bryson Bill improved the law to more clearly express what a patent has always meant, giving the inventor the right to exclude others from making, using or selling the product of the invention.

**Original Purpose.** To understand the meaning of a patent one must go back to the purpose of the patent law as expressed in the Constitution. It was to promote the progress of science and the useful arts. Its purpose was to help the public rather than the inventor. A great deal could be written on the philosophy of patent rights; whether they are property and therefore taxable as in many foreign countries, whether they are a desirable or an undesirable monopoly, whether they are natural rights and if so why should there be any limits to their life, etc. Our otherwise individualistic founding fathers made them subservient to the good of the public, and this philosophy has received quite general acquiescence.

It is generally conceded that the inventor owns his invention and has the right to keep it secret or to use it within the law as he sees fit. If he does not patent it, he has certain common law rights to it, but not the right to prevent others from making, using or selling the product of his invention which he gets upon obtaining a patent.

Actually, a patent is an agreement between the government, acting for its people, and the inventor, by which, in order to promote the progress of science and the useful arts, the people obtain from the inventor a disclosure of the invention. After 17 years from the date of the patent, however, it may be used by anyone.

Improvement patents on some valid patent do not give the inventor any right to use the invention of the first patent, so usually the owners of the two patents must get together if the improvement is to be used, or the owner of the improvement patent must await the expiration of the first patent.

**Mutual Agreement.** Understanding and appreciating the patent law outside of those who invent or who use patented devices in industry has unfortunately been poor. Too many otherwise intelligent people have the mistaken idea that the government has given the inventor a monopoly. The truth is that the government has traded him a 17-year monopoly on the use of something that naturally belongs to him for full disclosure of the invention so anyone can try to improve on it and can utilize it free of cost after the patent expires. This so-called monopoly serves the public interest in that it encourages someone to take a business risk in exploiting the invention and making its benefits available to the public by improvement in the consumer product or reduction in its cost.

Without patent protection, most of the inventions now contributing to our high standard of living and leisure time would never have been put into use. It is unfortunate that the word monopoly was ever associated with patents for it connotes those practices which the public so despises.

In the past, this attitude has prevailed in the courts to the extent that many unfair decisions voiding patents were made. As a matter of fact Edison once remarked that a patent was merely an excuse for a lawsuit. At one time, it was considered by many courts that invention always came as a "flash of genius," and any invention developed by systematic thought and experimentation was therefore not invention. However, this was changed by the 1952 law which provides that the manner of making an invention has nothing to do with its patentability. This law also provides that patents are to be presumed to be valid. This puts the burden of proof on the party attacking or infringing the patent and should reduce patent litigation and encourage individual inventors.

### How to Protect Your Invention

Every inventor should know how to protect his inventions from the date of their conception, and should in every instance act on this knowledge. It is a relatively simple and inexpensive procedure and it could be extremely important to the inventor.

Consider the importance of this in the interference case between Armstrong and de Forest on a regenerative radio circuit. Armstrong had crudely drawn up specifications and circuits and had them witnessed before a Notary Public. This brought the court decision in his favor that later turned out to be worth over one million dollars. Had he neglected this simple safeguard, he would undoubtedly have lost this valuable invention, even though he was the first to make it.

**Legal Proof.** You must establish legally acceptable proof of date of conception. In "Your First Invention—A System," which was published last month, the keeping of dated and witnessed notebooks on inventive ideas was strongly recommended as a step in learning how to invent. This same notebook serves another purpose, that of safeguarding your date of conception of invention, if properly witnessed and dated. Each page of the notebook should be understood, witnessed and dated by two persons who are apt to be available if needed for testifying as to the invention.

If changes or additions are made in these sketches and descriptions, it is advisable to make them in a differently colored ink and have them witnessed accordingly. If witnesses are not readily available or you do not wish to bother them by frequently making demands on them, you should carefully select your most important ideas and submit them quickly as patent ideas or formal disclosures to your company if you are working under a patent agreement.

This procedure will establish your date of conception not later than the date your invention was submitted. If you are not working under any patent agreement, the protection of your invention is then up to you. In addition to the witnessed notebook, other precautions should be taken. There are several ways that have been used suc-

cessfully, to establish the conception date that are effective in the Patent Office and in court. The following are recommended:

**1.** Carefully draw and describe in detail your invention, using ink, on a single large piece of paper and have it witnessed before a notary public by two persons to whom you have described it so that they thoroughly understand it. This paper may then, for additional proof, be folded to become in itself an envelope and sent by registered mail to yourself. Then, keep the receipt and the envelope.

**2.** Preserve all possible evidence. It is seldom that the initial conception drawing is the final invention. As changes are made, new drawings and descriptions should be made and witnessed as recommended. Then these new papers, etc., should be preserved with the first one. If you buy materials for testing such ideas or have a patent search made, keep the bills and the letters from the attorney conducting the search, together with the references obatined.

**Reduce Invention to Practice.** The patent laws require diligence on the part of the inventor in reducing the invention to practice. A series of witnessed drawings with descriptions showing improvements or proof of experimentation within the capabilities of the inventor, financially and otherwise, are satisfactory if not spread over an unreasonably long time. In some instances experimentation may extend over several years but it should be kept as short as possible and good reasons should be had for any delay.

However, filing for a patent is accepted by the Patent Office as constructive reduction to practice and is usually the best way to protect the invention from the charge of abandonment. In any event, the inventor has a minimum time of one year from the conception of an invention in which to file for a patent.

**Public Use.** Do not allow public use of your invention for one year before patent is filed. The patent law provides that an invention may not be in public use for more than one year before an application is filed to obtain a patent. If any experimental use beyond this one year limitation is tried, the operation should be carefully planned under the advice of a patent attorney.

Where any product from the operation is sold or offered for sale, extreme care must be exercised to establish that the experimentation was the prime reason for operation and production was incidental. Also that the operation was conducted under the control of the inventor.

**Why Can't I Practice My Invention in Secret?** You can if you have that kind of invention for it belongs to you. However, patents are offered to promote the progress of science and the useful arts and secrecy for a longer period than necessary to develop and test the invention would be contrary to this public policy. Do not try this without careful thought of the possible consequences and also consultation with a good patent attorney.

Many a good invention has been lost by this practice through some unexpected slip-up such as an employe proving unfaithful or some other inventor inventing the same thing and getting it patented. Although any patent so obtained is invalid if attacked by the original inventor, the invention becomes public property and the inventor has lost the advantages the invention provided and which could have been retained had he obtained a patent instead of resorting to secrecy.

### More Information

Here is some further information that may benefit you as an inventor:

**1.** Do not make inquiries of the Patent Office about your invention except by regular procedure on some pending patent application.

**2.** After a patent is issued, it is out of the jurisdiction of the Patent Office, and, therefore, the office is not concerned with questions of infringement, the scope of the patent, or any other questions that arise out of the grant. These matters are within the jurisdiction of the U. S. district courts.

**3.** No protection is provided by the patent law prior to the actual issue of a patent.

**4.** Damages cannot be recovered for infringement committed more than six years before filing suit for patent infringement.

**5.** The penalty for falsely marking an article "patented" when it is not is limited to $500.

**6.** Applications pending in the Patent Office are preserved in secrecy. No information will be given, without written authority, respecting the filing by any particular person of an application for a patent.

**7.** The *Official Gazette,* published weekly contains claims of all patents issued, including re-issues and designs, with portions of the drawings selected to illustrate the inventions claimed. Also included are illustrations of trademarks registered, and decisions rendered by the courts in patent cases and by the Commissioner of Patents, and other special matters of interest to inventors. Write the Superintendent of Documents, Government Printing Office for subscription rates.

**8.** In the event two or more inventors file applications for the same invention, the Patent Office declares an interference and requires each inventor to submit proof of his earliest conception date to determine the one to whom to issue the patent. If an inventor, experimenting on the development of an invention, finds that a patent has been issued on a similar invention, he may, within one year after the invention issues, file an application for a patent containing one of the claims of the issued patent and thereby create an interference. Usually, it is the best practice in interferences for the owners of the conflicting inventions to get together to determine who was the first inventor. Sometimes, the inventor who was first finds in the other his best prospect as a purchaser or a licensee.

**9.** If you own a patent and wish to sell it or license its use, you may have it entered without cost in the Patent Office's Register of Patents Available for Licensing. Its entry will be published in the *Official Gazette* of the Patent Office and other means employed to call it to the attention of those who might be interested. This is a free service and requires only a statement that you will grant licenses under your patent on stated or reasonable terms.

**10.** You can find books on patent laws and procedure in almost every public library that go into details much more thoroughly should you have questions or need information which I did not feel justified in including.

**PART VII WILL APPEAR NEXT MONTH**

# What's Happening . . .

## . . . in the Industry

# LPG Sales Jump 9.4 Percent in 1958

**Upward trend is expected to continue. The domestic market accounts for the largest increase.**

LPG sales in 1958 appear to have increased 652,300,000 gallons (9.4 percent over 1957) raising total sales to 7,591,400,000 gallons. This is 30 percent above the average annual LPG sales increase of 500,000,000 gallons (from 1950-58). The trend shown in the graph should continue because of the tremendous domestic, motor fuel, and chemical potential still existing.

**Domestic & Commercial** — Sales were up 467,230,000 gallons (15.2 percent over 1957) to 3,534,300,000 gallons. This equals 46.5 percent of total sales, which compares with 44.2 percent of total sales in 1957 and 45.2 percent in 1956. The domestic market continued to account for nearly one-half of all LPG sales.

**Motor Fuel**—Sales were up 16,200,000 gallons (2 percent over 1957) to 821,200,000 gallons. This equals 10.8 percent of total sales, indicating that the growth in the motor fuel market has kept pace with the growth of the industry.

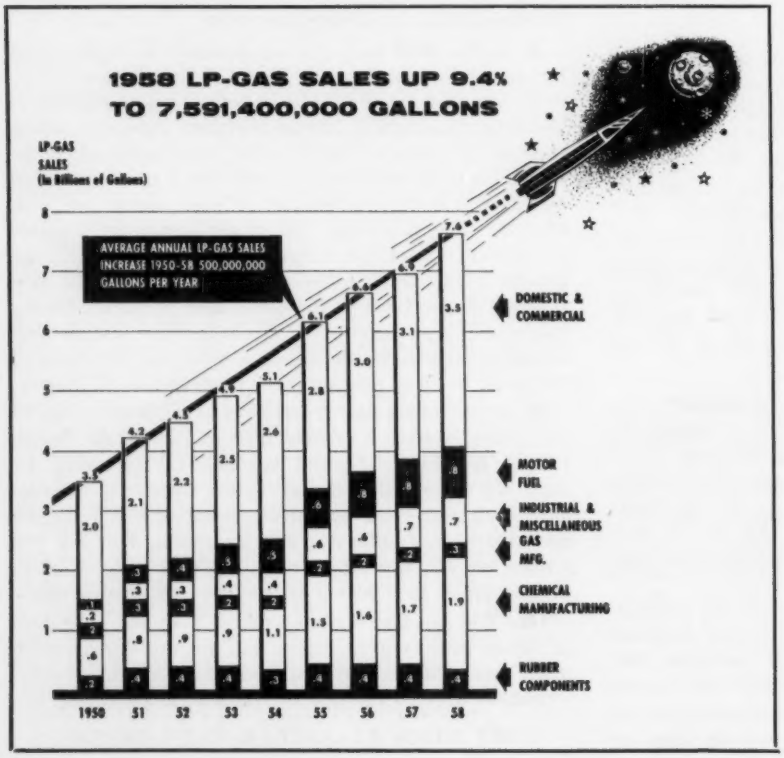
**Industrial and Miscellaneous** — Sales were up 63,100,000 gallons (9.2 percent over 1957) to 748,400,000 gallons. This equals 9.9 percent of total sales. The trend of industrial and miscellaneous sales is slightly upward.

**Gas Manufacturing**—Sales were up 23,300,000 gallons (10.1 percent over 1957) to 254,500,000 gallons. This is 3.4 percent of total sales, approximately the percentage of total sales shown for the past five years.

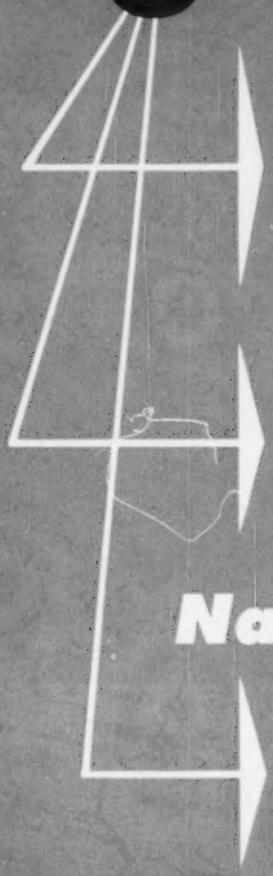
**Chemical Manufacturing**—The sale of LPG as a raw material for manufacturing chemicals was up 136,900,000 gallons (7.9 percent over 1957) to 1,869,200,000 gallons. This is 24.6 percent of total sales, compared with 25 percent in 1957 and 17.9 percent in 1950. Figure 1 shows that chemical manufacturing has increased an average of 135,000,000 gallons a year since 1950.

**Rubber Components**—The volume consumed in manufacturing synthetic rubber is down 54,400,000 gallons (13 percent from the amount used in 1957) to 363,800,000 gallons. This use is 4.8 percent of total sales, compared to 6 percent in 1957 and 8.9 percent in 1951.

**Domestic and Commercial** — In February and March, 1958, an unusual, prolonged cold spell in the south and southeastern United States, resulted in a very high demand for LPG, principally for house heating. About 23,000,000 gallons of the 467,230,000 gallon increase in the domestic and commercial market over 1957


1958 LP-GAS SALES UP 9.4%
TO 7,591,400,000 GALLONS
LP-GAS SALES (In Billions of Gallons)
AVERAGE ANNUAL LP-GAS SALES INCREASE 1950-58 500,000,000 GALLONS PER YEAR
DOMESTIC & COMMERCIAL
MOTOR FUEL
INDUSTRIAL & MISCELLANEOUS
GAS MFG.
CHEMICAL MANUFACTURING
RUBBER COMPONENTS
1950 51 52 53 54 55 56 57 58

# THESE 3 ARE YOUR LUCKY NUMBERS



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1. **RESOURCES** OF PRODUCTION, TRANSPORTATION AND STORAGE PLUS WARREN . . .
2. **EXPERIENCE** AS A SPECIALIST IN ITS FIELD ASSURE YOU OF WARREN'S . . .
3. **ABILITY** TO GIVE YOU . . .

1. **QUALITY** (WHATEVER THE GRADE)
2. **QUANTITY** (WHATEVER THE VOLUME)
3. **SERVICE**, COMPLETE AND DEPENDABLE DELIVERIES OF

## Natural Gasoline

1. **WHEN** YOU WANT IT,
2. **WHERE** YOU WANT IT AND THE
3. **WAY** YOU WANT IT.

**WARREN**
**PETROLEUM CORPORATION**

TULSA, OKLAHOMA • Cable Addresses: STAVOLENE, WARREN

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## What's Happening. . .

occurred because of this cold spell. This illustrates the tremendous effect weather has on the LPG business. It is estimated that the domestic and commercial market for LPG in 1958 totaled 3,534,300,000 gallons, up 15.2 percent (467,230,000 gallons over the 3,067,070,000 gallons sold in 1957).

The most important factor in domestic growth continued to be house heating. Central gas heat is becoming more and more popular, and new customers continued to convert to LPG for house heating from other fuels.

In most of the country, the conversion of 100 pound cylinder customers to bulk distribution continued. When domestic customers expand their use beyond the cooking and water heating load they "graduate" into bulk distribution.

The use of LPG in agriculture continued to expand, increasing the summer load. Some agricultural uses are for irrigation pump engines, crop and grain drying, farm tractors, and weed burning.

Residential gas air conditioner sales exceeded 7,000 units in 1958, compared to approximately 2,500 units sold in 1957. Although most air conditioners sold use natural gas, the sales figures indicate the growing demand for LPG units. Several gas air conditioners are available on the market and others are in advanced stages of development.

**LP-Gas Appliances**—During most of 1958 LPG appliance sales were down—but last quarter 1958 indications were that the tide had turned. Sales improvements were evident.

**Supply**—Over-all production of LPG at natural gasoline plants and refineries increased approximately 2 percent during 1958. Twenty-six new plants came on stream during the year and several existing facilities were expanded. It is estimated that 13 new plants will be added in 1959. Canadian LPG production capacity is expanding rapidly, but the effect of this on the U.S. market is not yet known.

Underground storage capacity for LPG continues to grow. The available underground storage capacity now totals more than 1,600,000,000 gallons—an increase of almost 20 percent over 1957 with an additional 100,000,000 gallons currently under construction. Additional underground storage is in the planning stage.

**Transportation**—Improvements of LPG transportation facilities were highlighted during the year by conversion of the Little Big Inch Pipeline from natural gas to refined petroleum products service with a capacity of 185,000 bpd.

Pipeline movement of LPG was further increased by the addition of lines carrying natural gas liquids plus comparatively short pipelines to carry chemical plant feedstocks, particularly in the Gulf Coast.

The rail transportation picture was improved when railroads rejected an authorized rate increase in ten Southeastern states. In addition there will be substantial general rail freight reductions in effect early in 1959.

Water transportation of LPG continues to receive considerable attention. Three new inland waterway barges were placed in service during the year and one new ocean-going tanker is under construction and scheduled for delivery early in 1959.

Movement of LPG by transport trucks continued to grow at a rapid rate with transports having a water capacity of 10,000 gallons becoming more common.

**Safety Developments**—Pamphlet 58, published by the National Fire Protection Association and National Board of Fire Underwriters was revised to keep pace with new developments in equipment and safe operating techniques. Also revised was NFPA Pamphlet No. 59, covering LPG at utility gas plants, to recognize and properly provide for use of containers having a water capacity of up to 200,000 gallons in such facilities.

**Outlook**—Even though business activity in general was at a reduced level throughout

PRINCIPAL LP-GAS PIPE LINES & WATER TERMINALS

"Take a tip from me—

## One slip can cost more than USS Multigrip"

**Men who work in slippery places** . . . push heavy loads . . . or merely walk up and down stairs know what it means to have sure traction underfoot.

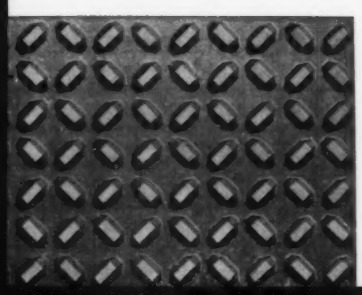
They can't wear shoes with cleats, but you can give them a floor with cleats—USS* Multigrip. Dozens of little studs provide maximum skid resistance in any direction. They are flat on top, easy to walk on—but do not catch the shoe.

Whether a landlubber or a seafarer, Multigrip assures you the same fine service. Wet or dry, Multigrip supplies safety plus.

For locations that take a heavy beating from traffic, Multigrip provides a floor that will stand up under years of constant use. Oil won't soak in and can be easily removed with regular cleaning materials. You save money by having a floor that is easy to sweep or flush clean, lasts for years with no maintenance.

**On your next inspection trip, look around for danger spots—and make them safe with Multigrip*. You can get it from our local distributor.**

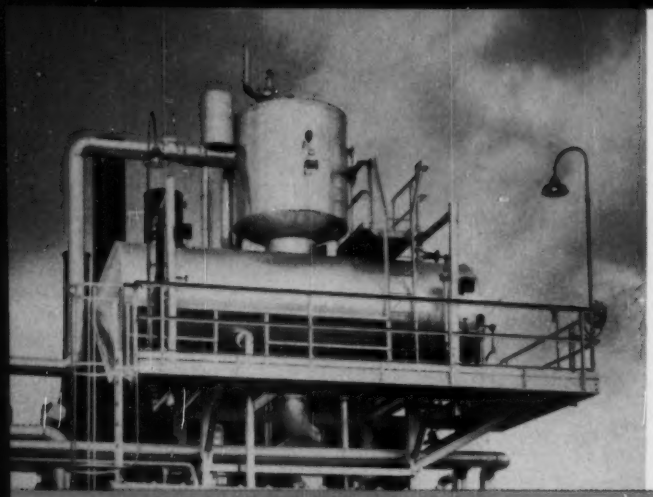
*Sold by leading distributors from coast to coast.*



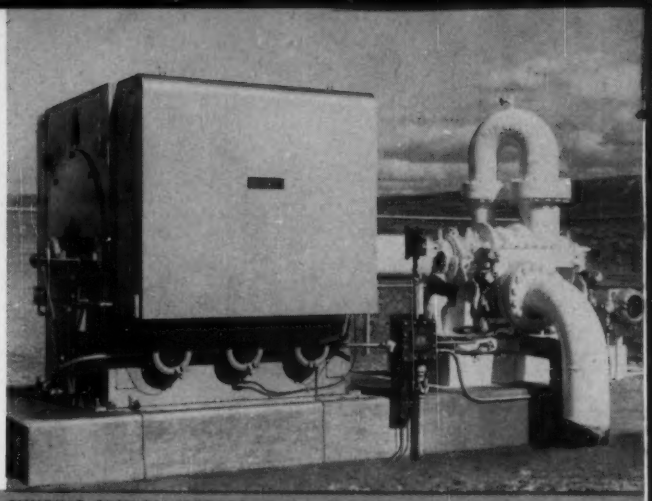
United States Steel Corporation – Pittsburgh
Tennessee Coal & Iron – Fairfield, Alabama
Columbia-Geneva Steel – San Francisco
United States Steel Supply – Steel Service Centers
United States Steel Export Company

USS United States Steel

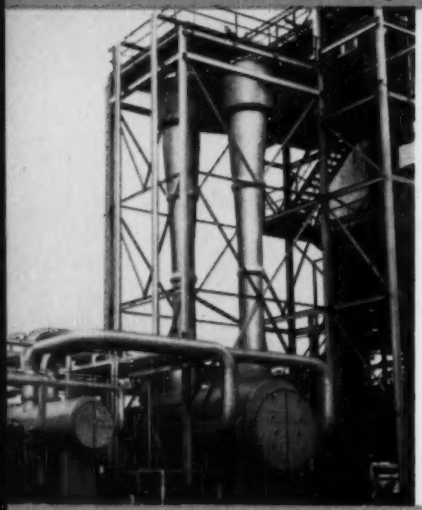
*TRADEMARK



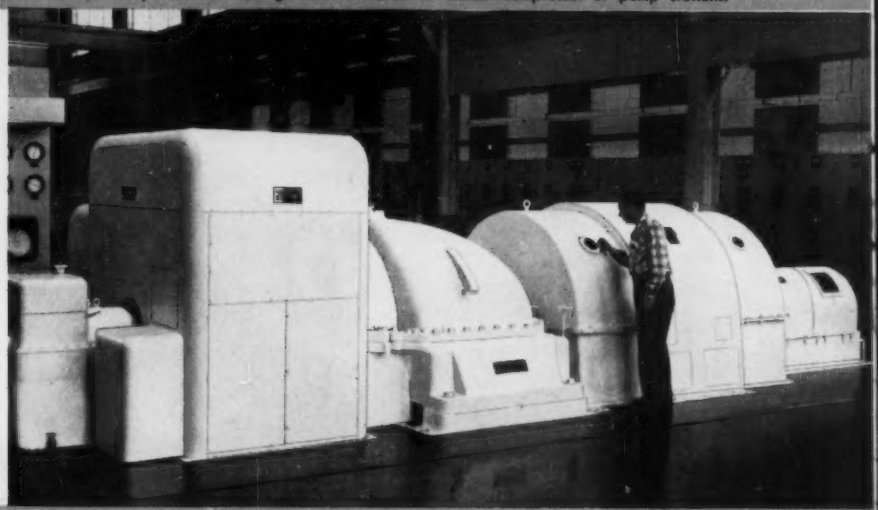
**DEAERATING FEEDWATER HEATERS**—precisely engineered by Elliott to requirements and space limitations—range in size to 2,500,000-lb-per-hr capacity. Elliott was first to advocate deaeration of water to prevent corrosion. Above refinery installation—a vertical heater on horizontal storage tank—is rated 200,000 lb per hr.



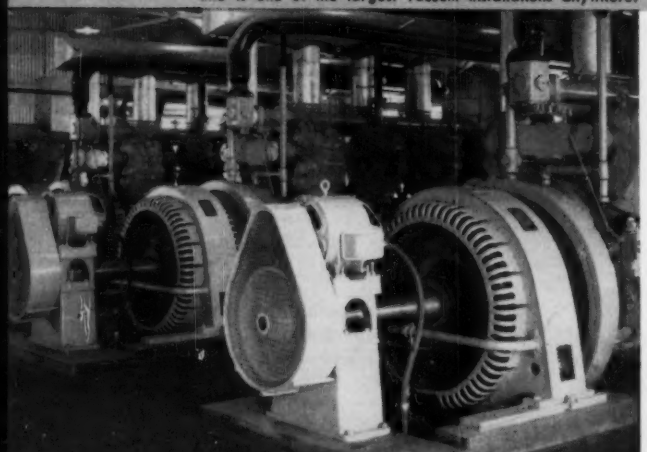
**PUMPING STATION MOTORS**—"tailored" by Elliott to outdoor pipeline service, eliminate costly housing. Above, Elliott 1500-hp, 2-pole "weather-protected" squirrel-cage motor direct-connected to two-stage oil pump. Elliott also builds externally-ventilated and inert gas-cooled motors for indoor compressor or pump stations.



**EJECTORS**—designed and built by Elliott—range from size of man's hand to size of three-story building, such as the above twin three-stage ejector, with intercondensers, which serves one of the world's largest crude oil installations and is one of the largest vacuum installations anywhere.

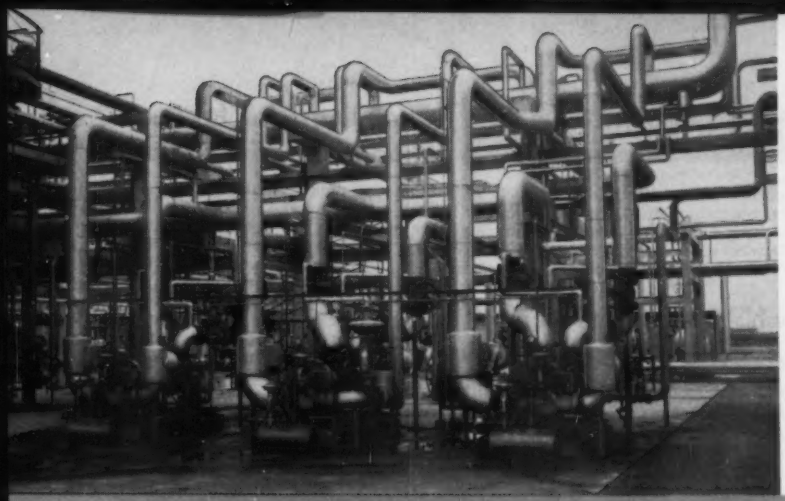


**TURBINE-GENERATORS**—this is one of three Elliott 4000-kw machines in one refinery power plant. They are served by Elliott surface condensers. Elliott builds turbine-generator units in size ratings up to 44,000 kw, which are noted for capability beyond nameplate ratings and dependable long-term service.



**DIESEL-ENGINE GENERATORS**—built by Elliott—are the product of 60 years experience. Here are three Elliott 280-kw, 400-rpm, gas-engine-driven generators serving a natural gasoline plant. They feature neat appearance, structural rigidity, long-lasting insulation and easy accessibility for routine cleaning and maintenance.

**TURBOCHARGERS**, above, right, are some of the 72 Elliott machines which helped increase pipeline pumping capacity 40% by supercharging old horizontal gas engines in nine compressor stations. No other manufacturer has so much experience in building turbochargers—covering the whole field of turbocharged engines.



**TURBINES,** single- and multi-stage, range from 5 to 20,000 hp. A typical line of Elliott single-stage turbines driving oil pumps is shown above. Simple design and rugged construction, plus excellent service records, have made these turbines favorites in refineries and gasoline processing plants.

**MOTORS,** totally-enclosed, fan-cooled, here drive pumps handling condenser water from cooling towers. Elliott introduced the "ribbed-frame" enclosed motor back in 1941. The explosion-proof version of this Elliott C-W motor is particularly well adapted for use in the petroleum industry.

*throughout the petroleum industry*

# ELLIOTT EQUIPMENT IS ON THE JOB

**An Elliott CONDENSER,** (with EJECTOR and MOTOR and [illegible] pump drives) . . . and **CENTRIFUGAL COMPRESSORS** serve this refinery. Elliott has long experience in designing and building steam and electrical equipment to meet rugged, long-term 'round-the-clock service requirements of the petroleum industry.

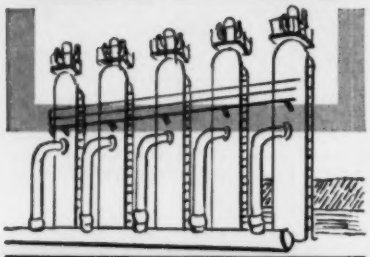
Q9-2

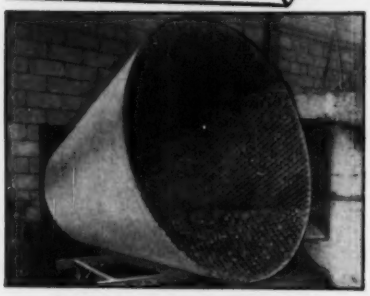
**ELLIOTT Company**

JEANNETTE, PENNSYLVANIA

STEAM TURBINES • MOTORS • GENERATORS • DEAERATING HEATERS • EJECTORS • CONDENSERS • CENTRIFUGAL COMPRESSORS • TURBOCHARGERS • TUBE CLEANERS • STRAINERS

FEWER "TURN-AROUNDS"





Shutdowns for repairs of fire clay linings in refractory units are expensive. The frequency and duration of these shutdowns can be greatly reduced by the use of a steel grating armor known as "Gridsteel", which holds the castable refractory linings in place longer and armors them against the bombardment of catalytic elements.

"Gridsteel" is available in a special loose clinch to conform easily to curved surfaces.

**For complete information, write for brochure on Irving "Gridsteel" Contour Retainer Mesh**

★

"A Fitting Grating for Every Purpose"

**IRVICO**

**IRVING SUBWAY GRATING CO., Inc.**
*Originators of the Grating Industry*

**Offices and Plants at**
**5090 27th St., LONG ISLAND CITY 1, N. Y.**
**1890 10th St., OAKLAND 23, CALIFORNIA**

## What's Happening . . .

most of the year, LPG sales increased 30 percent more than the average increase of recent years. With the economy showing definite recovery trends, there is every indication that 1959 will be another good year.

## New NPC Members Named, Parley Held December 29

The National Petroleum Council will have 102 new leaders in the oil and gas industry this year. Secretary of the Interior Fred A. Seaton, in making the appointments, said "it is my hope that you and other members of the council will adopt the revised procedures which will meet the attorney general's criteria for business advisory groups (decided December 29), and carry on the advisory activities and studies so vital to the Interior department and other government agencies."

Changes in the council's organization and procedures considered at the meeting included:

- A provision for the appointment of full time salaried officials of the Interior department, as co-chairmen of the council and its activities.
- Procedures for the appointment of members to committees and sub-committees and the conduct of these meetings.
- Preparation and custody of the minutes of meetings.
- Calling of meetings and preparation of agenda for them.

## Supreme Court Makes Major Labor Ruling

Rulings by the National Labor Relations Board setting up collective bargaining units may be appealed to the federal courts according to a recent ruling by the U.S. Supreme Court. The decision, which may open up a new area of litigation in the labor field, is a defeat for NLRB, which argued such rulings may be reviewed by the courts only if they are the basis for unfair labor practices charges.

In a dissenting opinion, two justices said the decision "opens a gaping hole" in Congressional policy against resort to courts in such cases, and that it will be easy to "get a foot in the district court door." Dissenting Justice Brennen said "both unions and management will be able to use the tactic of litigation to delay the initiation of collective bargaining when it suits their purposes."

## Gas Liquids Data Shown By Bureau of Mines

Daily average production of natural gas liquids in September was 33.5-million gallons, same as in September, 1957, reported the Bureau of Mines. Daily average production of liquefied gases at refineries was 6.6 million gallons, 11 percent greater than in 1957.

Demand for liquefied gases for fuel and chemical uses in September was 17.9 million gallons, down four percent from 1957. Daily average demand for natural gasoline in September was 11.9 million gallons, down one percent from September, 1957. Underground stocks for September reached 730 million gallons, an increase of 78 million gallons during the month.

## Cleanliness for Jet Fuel Expounded in Esso Paper

A continuous cleanliness program for jet fuel suppliers, and steps that equipment manufacturers can take to improve their jet fuel contamination control and detection devices, are recommended by three Esso Export Co. researchers in an "Esso Air World" article.

In "Control and Measurement of Cleanliness Quality in Turbo Fuel," D. D. Love and A. R. Ogston of Esso Export, and C. E. Loeser of Esso Research & Engineering Co., outline what the company has learned about how clean and "dry" fuels must be to assure safe, efficient and economical operation of jets. Results of operating experience must be pooled among engine builders, equipment manufacturers and fuel suppliers as it is acquired, and uniform standards of cleanliness maintained, say the authors.

## Gas Outlay to Rise in '59 But Oil Will Be Down

United States business will start the new year by spending more for plant and equipment, with natural gas companies boosting outlays about $500 million from the mid-1958 level because of plans for pipe line expansion, according to a recent government survey.

Petroleum, along with many non-durable groups, will go into 1959 with small decline in expenditures. The petroleum recession low was in the third quarter of 1958, when it hit a seasonally-adjusted annual rate of $2.17 billion. Fourth quarter spending was at a rate of $2.30 billion. A rate of $2.28 billion has been indicated for the first quarter of 1959.

## Health Department to Study Exhaust Effects

The effects of automobile exhaust as a health hazard are being investigated in a research study by the Public Health Service, Department of Health, Education and Welfare. Two large irradiation chambers at Roger A. Taft Sanitary Engineering Center, Cincinnati, will be used in experiments on bacteria, plants, and animals. Research instruments valued at $100,000 will be used.

Secretary Arthur H. Fleming said that both the automobile industry and Congress should step up efforts to combat air pollution. Industry should intensify exhaust research and permit the government to hold hearings and make recommendations on pollution control, he said. He also called for more community and industrial action.

## State Department Sets Up Science Officer Program

The Department of State has re-established its overseas science officer program with the appointments of seven distinguished scientists who will serve as science officers in U.S. embassies in London, Paris, Rome, Bonn, Stockholm, and Tokyo. Although assigned to a specific embassy, they will also provide scientific assistance in embassies in adjacent areas. The men selected are: Dr. Thomas H. Osgood, dean, School for Advanced Graduate Studies, Michigan State University, for London; Dr. Edgar L. Piret, professor of chemical engineering, University of Minnesota, for Paris; Dr. Edward H. Cox,

retired head of department of Chemistry, Swarthmore College, as deputy science officer for Paris; Dr. Walter Ramberg, chief, Mechanics division, National Bureau of Standards, for Rome; Dr. Ludwig F. Audrieth, professor of chemistry, University of Illinois, for Bonn; Dr. Julian E. Mack, professor of physics, University of Wisconsin, for Stockholm; and Dr. Willis R. Boss, professor of zoology, Syracuse University, for Tokyo.

These appointments, for two years, are the first of a series for the science program of the Department of State under Dr. Wallace R. Brode, science adviser to the secretary. Still to be appointed are officers for U.S.S.R., India, and South America, and deputy science officers for all the posts except Paris, to which Dr. Cox is being assigned.

## API Discontinues Old Viscosity Standards

The American Petroleum Institute has discontinued its three viscosity standards—Alpha, Betta, and Gamma. Under sponsorship of the American Society for Testing Materials, Cannon Instrument Co., State College, Pa., will furnish seven new oil standards for viscometer calibration.

API said the 1958 versions of ASTM Tentative Method D, 445 Kinematic Viscosity, and Standard Method D 88, Saybolt Viscosity, will refer to the new series. Approximate viscosities of the new standards, available at $15 per pint, F.O.B., State College, are:

SAYBOLT VISCOSITY, SECONDS

| Viscosity Oil Standard | UNIVERSAL | | FUROL |
|---|---|---|---|
| | At 100 F | At 210 F | At 122 F |
| S 3 | 36 | ... | ... |
| S 6 | 46 | ... | ... |
| S 20 | 100 | ... | ... |
| S 60 | 290 | ... | ... |
| S 200 | 970 | ... | ... |
| S 600 | ... | 150 | 133 |

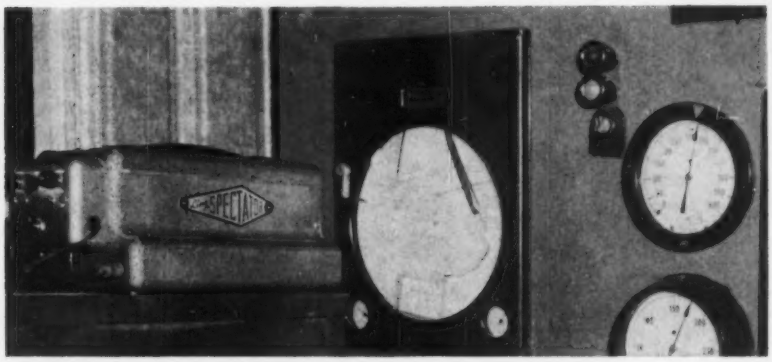
KINEMATIC VISCOSITY, CENTISTOKES

| Viscosity Oil Standard | At −65 F | At −40 F | At 100 F | At 122 F | At 210 F |
|---|---|---|---|---|---|
| S 3 | 340 | 86 | 3 | ... | .. |
| S 6 | ... | .. | 6 | ... | .. |
| S 20 | ... | .. | 20 | ... | .. |
| S 60 | ... | .. | 60 | ... | .. |
| S 200 | ... | .. | 200 | ... | .. |
| S 600 | ... | .. | 600 | 280 | 32 |
| S 2000 | ... | .. | 2000 | ... | .. |

## Special Stamp Will Mark Oil Centennial

A special commemorative stamp will be issued this year to mark the centennial of the U.S. oil industry, the American Petroleum Institute has been advised by the Post Office Department. It will be issued at Titusville, Pa., "birthplace" of the American oil industry, on August 27, and 100 years to the day that the first commercial oil well became a reality.

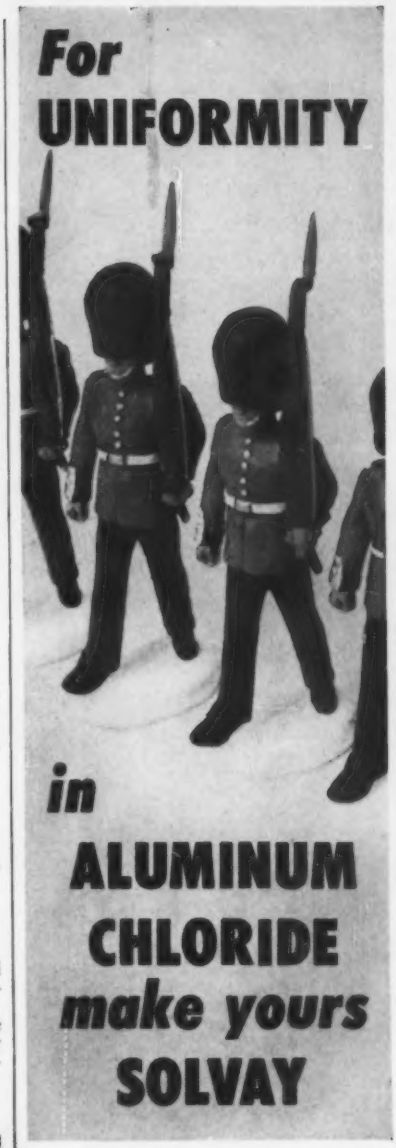
The denomination, size, and color of the petroleum stamp will be announced later by Postmaster General Arthur Summerfield.



## Pan Am Plant Uses Closed-Circuit TV

Probably the first closed-circuit television system installed for use as an operating instrument in a gasoline plant is now operating at Pan American Oil Co.'s Slaughter gasoline plant, Hockley County, Texas.

Purpose of the installation is to increase safety and on-the-job efficiency of the operator responsible for two 30,000 pounds per hour, 300-pound steam boilers, two heat medium oil fired heaters, and the sulfur recovery installation, which includes a 15,000 pounds per hour, 300-pound waste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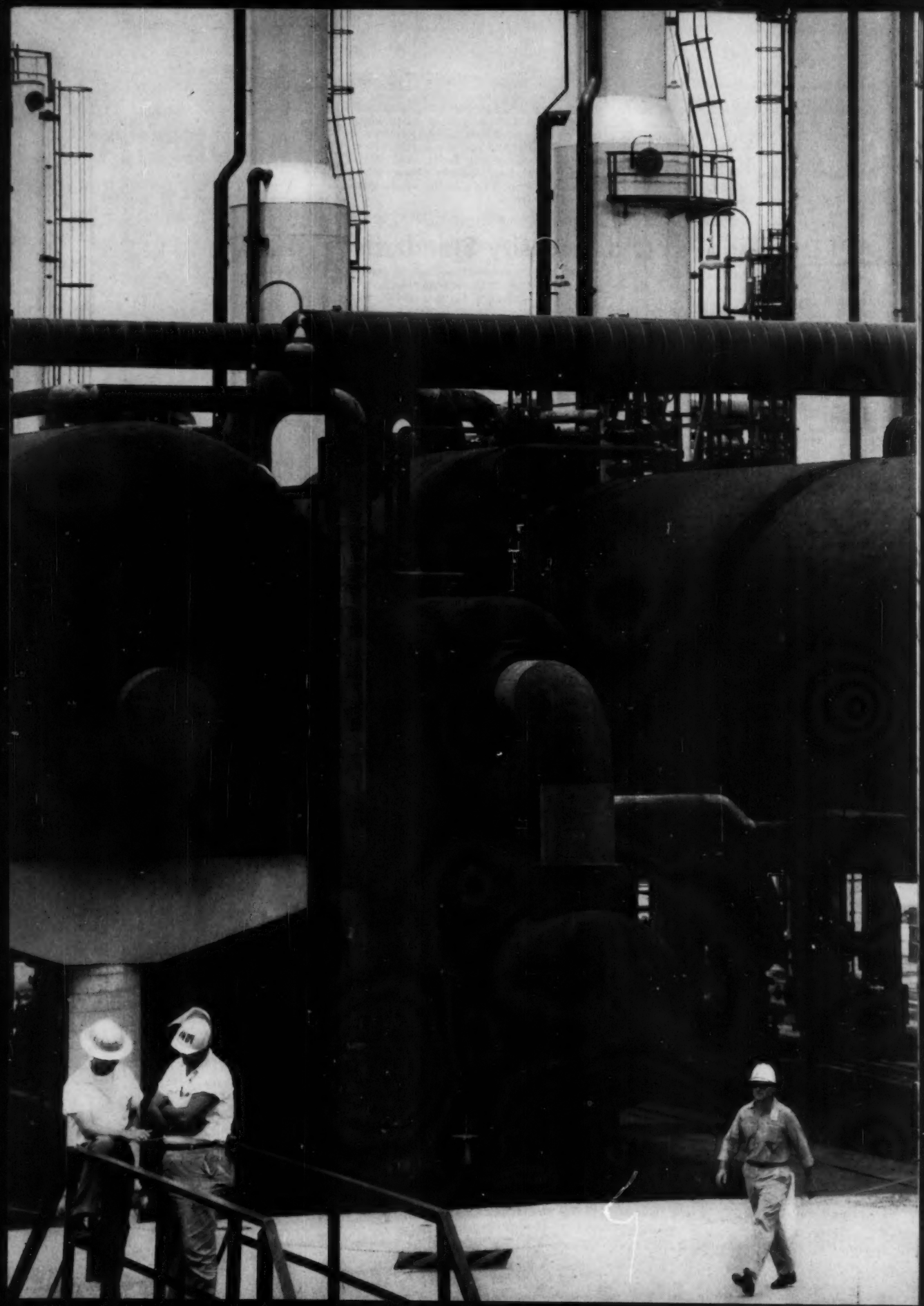


**These Stratco Effluent Refrigeration reactors** are part of the alkylation section of Texas Butadiene & Chemical Corporation's plant in Channelview, Texas. The unit obtains its butylene feed from the dehydrogenation of butane into butadiene and butylene. Depending on marketing requirements, the butylene may be used to make alkylate or recyled back into butadiene production. Alkylation capacity is 6,500 b.p.s.d.

**ALKYLATION**

## *There are no easy answers*

Automobile engines will continue to demand higher performance from gasolines. Octane numbers will rise and sensitivity ratings will decrease. More gasoline will be produced, and more of it will be of premium grade. The refiners' answer to this challenge will be alkylate—lots of it.

Adding alkylation capacity involves some complex decisions, the weighing of a multitude of factors. Which process to invest in under a given set of conditions; what level of quality to aim for; how large a plant to build—these are difficult questions. To answer them requires a thorough understanding of all the processes, their economics and their practicability under various circumstances.

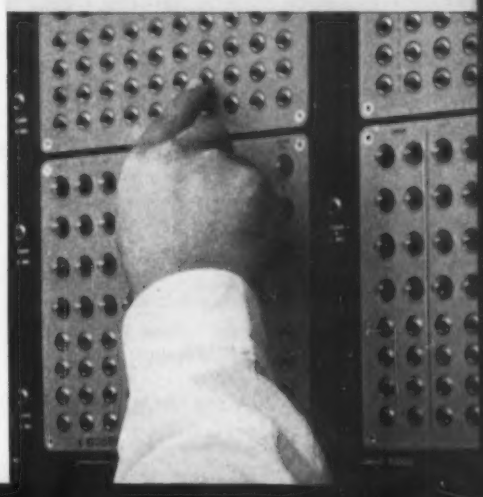
Nearly one-fourth of all the alkylation plants existing today were designed and built by Fluor. This fund of practical experience encompasses all processes under a great variety of circumstances. Fluor's broad knowledge of alkylation should be most helpful to you in planning a plant to fit your set of conditions.

The Fluor brochure, "Alkylation Plants," is a brief guide to the various processes. Write to Dept. 16, The Fluor Corporation, Ltd., 2500 South Atlantic Boulevard, Los Angeles 22, California.

*When you consider expansion... the most important investment you can make is in the creative ability of men.*

**FLUOR**

*Engineers and Constructors*



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FOR PLUS SERVICE

SERV-RITE drilled protecting wells are made in types, lengths, and of alloys to meet any temperature and pressure condition in vessels and flow lines.

Every well is carefully made to assure a plus service. Selected bar stock is machined to within accurate limits. Bore concentricity is held within 5% of wall thickness, depending on well length. They are tested to withstand pressures up to 3000 psi., depending on the wall thickness. Exterior surface has a mirror-like finish for minimum resistance to flow in lines.

Complete assemblies can also be furnished with suitable thermocouple, head, flange, fittings, etc.

Give SERV-RITE a trial on your next drilled well requirements. There is none better.

***Write for Bulletin No. 2000***
*for specifications, size, and ordering information on SERV-RITE drilled wells.*

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*Manufacturers • Engineers • Distributors*

**615 West 30th Street, Chicago 16, Illinois**
**2019 Hamilton Ave., Cleveland 14, Ohio**


## What's Happening. . .

heat steam boiler.

This installation enables the steam boiler operator to monitor critical sulfur unit control instruments from his central work location in the boiler area, which is about 260 feet from the sulfur unit control building. The closed-circuit TV permits the operator to see critical controls as they actually register.

The installation consists of a TV camera transmitter installed in the sulfur unit control building, a picture screen located in the boiler control building, and a coaxial cable joining the two instruments.

From a central work location the operator can, via TV, monitor critical instruments such as the sulfur unit waste heat boiler level, the boiler feedwater pump discharge pressure, the steam condenser condensate temperature, the closed system condensate alarm, and the flow ratio recorder—$H_2S$ and air to furnace.

Utilizing the monitor, the operator has constant surveillance of sulfur unit boiler controls. This meets requirments of the Texas boiler law regulations governing unattended operation of high pressure steam boilers.

Pan American reports that operating experience so far has been very satisfactory, and the TV technique shows great promise of increased safety and efficiency in this and other plant operations.

## Low-Cost Energy Is Key to Our Standards

Oil and gas are becoming increasingly expensive to find and produce, **D. T. Staples**, chairman of Tidewater Oil Co., has warned.

Pointing out that oil and gas now supply about 70 percent of all energy used in the U.S., Staples said that wells drilled in this country today have less chance of reaching oil and gas in commercial quantities than ever before. And, he added, these wells must be drilled far deeper than previously, increasing production costs.

Speaking on "America's Energy Stockpile" at a joint meeting of the Phoenix area Kiwanis Clubs, Staples said it is fortunate that our increasingly costly domestic oil is being supplemented with ". . . oil developed in other countries with American techniques and dollars." He said "we can draw upon huge reserves of coal, waterpower, oil shale, nuclear energy or even upon the oil locked in Canada's Athabasca Tar Sands," but cautioned that since tremendous investments will be needed to make this energy commercially available, the important consideration for the American consumer is how much it will cost.

Another reason why domestic oil is getting more expensive, Staples said, is that Americans demand more oil products each year despite the fact that U.S. petroleum reserves actually decreased in 1957.

He observed, "that the U.S., with only 13 percent of the free world's oil reserves, produces and consumes over half of the

Quoth Sir Galva-Knight:

CHOOSE YOUR WEAPON FOR THE DUEL AGAINST *CORROSION*

*METALLIZING*

The *big gun* in the battle against corrosion is the *metallizing* gun, in the hands of Nowery J. Smith Company expert applicators. Metallizing provides a tough, durable coating of metallic zinc or aluminum for long-term protection against both atmospheric and cathodic corrosion. Always choose metallizing for in-plant *or* job-site application . . . and for the best in metallizing always call the Nowery J. Smith Company in Houston.

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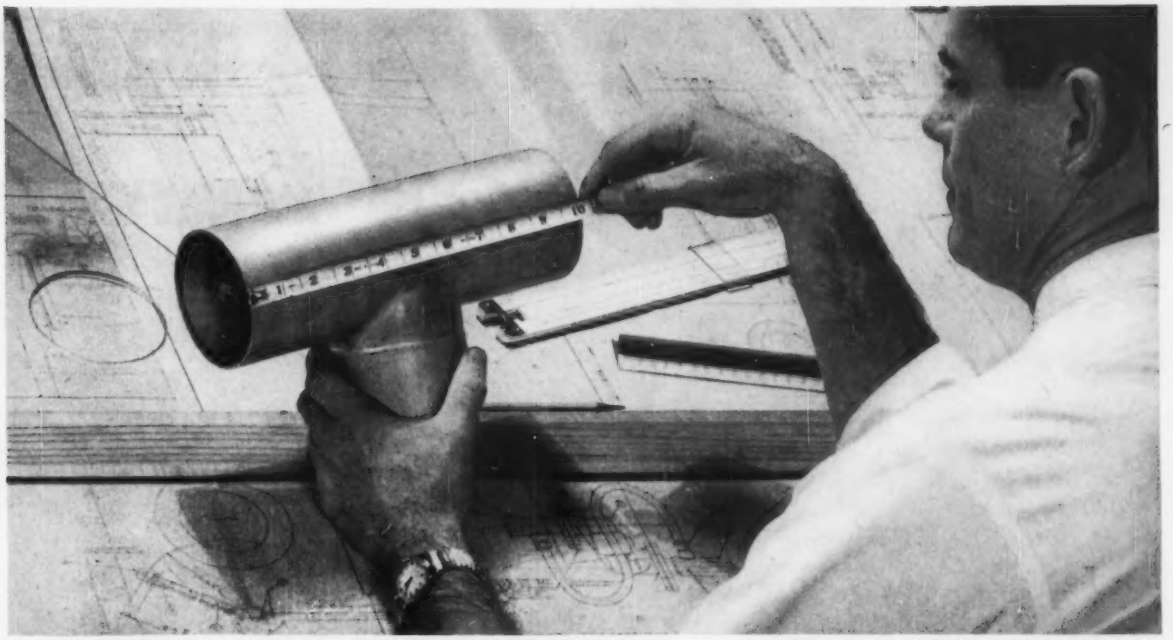
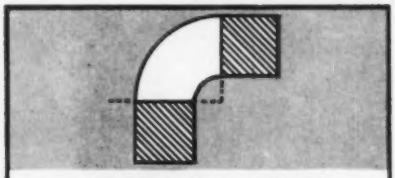


# SAVINGS ARE MEASURABLE...START TO FINISH WITH *LONGER LENGTH* SPEEDLINE FITTINGS



**HERE'S HOW YOU CAN CUT PIPING COSTS**

A conventional 90° elbow is shown inside the dotted line. The shaded areas indicate the extra length you get with a Speedline fitting—at no extra cost. For example, on a 3" Speedline Elbow it means 4" more pipe. Thanks to the longer length of all Speedline fittings, all types of joints are made more easily . . . cost less . . . than with conventional fittings. Make your own comparisons.

*For location of Authorized Distributor nearest you, see Speedline listing on page 593 in Chemical Engineering Catalog.*

With this 3" Speedline Tee you get 3¼" "*more length*" at no extra cost. Speedline's *tangential feature* cuts costs and design detailing, too . . . lets you select the best joint to meet assembly requirements . . . means more clearance for welding and easier pipe aligning. Flange where you want to, weld where you want to . . . *any* type joint can be used on *any* or *all* ends of a Speedline corrosion resistant fitting!

Greater flexibility of Speedline long length fittings adds up to faster assembly and *lower installed costs*—even for the most complex process piping system. And, of course, Speedline corrosion resistant fittings *cut material costs two ways:* they give *more* pipe length per fitting and they facilitate use of economical *light wall stainless* steel pipe.

Before you plan any new installation or system addition, investigate the many advantages of Speedline's *tangential* feature. Write for Speedline Catalog showing how you save with the complete line of Speedline fittings.

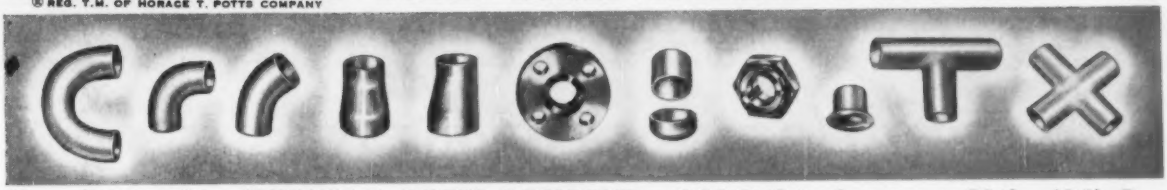
Speedline®

® REG. T.M. OF HORACE T. POTTS COMPANY

## STAINLESS STEEL FITTINGS

**SPECIALLY DESIGNED FOR SCHEDULES 5 AND 10 PIPE**

P-900



**Manufactured by HORACE T. POTTS COMPANY • 566 E. Erie Avenue • Phila. (34), Pa.**

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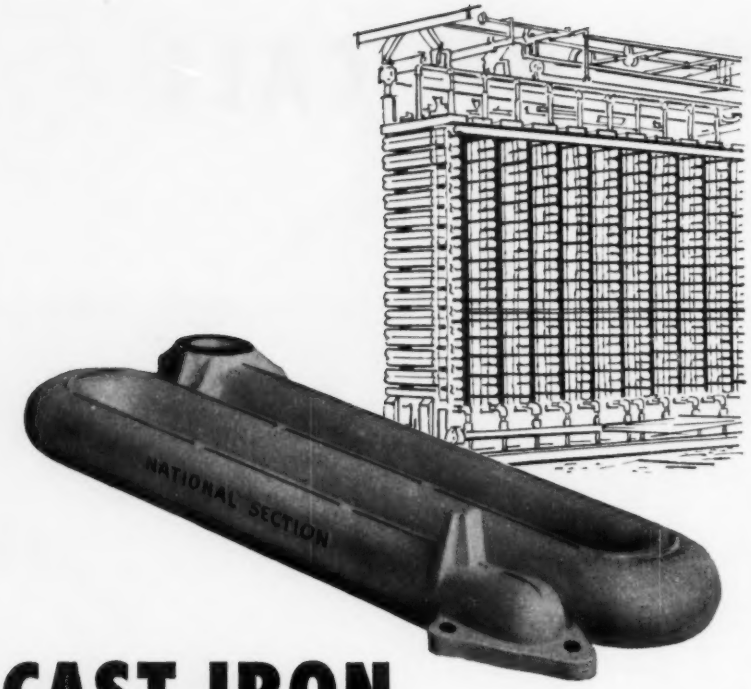


CAST IRON FOR COOLING CORROSIVES

National-U.S. Cast Iron Sections are the most widely used heat transfer units for sulfuric acid cooling in sludge recovery and contact plants—and have been, for many years. More and more, process engineers are looking into the possibility of using these units for other acids and corrosives in the chemical and petrochemical industries.

National-U.S. engineers can contribute valuable help from this background of experience in these fields. Call on them when you have a problem of heating or cooling corrosive materials in your operation.

*Write or phone to the address below for help on your problem.*

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*Heat Transfer Division*
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342 Madison Avenue • New York 17, New York

## What's Happening. . .

oil currently being produced and consumed in the free world."

Americans use so much oil, that "if everyone else in the world outside the U.S. suddenly began to use as much oil per capita as we do, the world's present known oil reserves would be used up in less than five years," he said.

### NLGI Elects 1959 Officers And Board of Directors

Officers and directors for 1959 were elected at the National Lubricating Grease Institute's recent 26th annual meeting. F. E. Rosenstichl, the Texas Co., is the president; H. A. Mayor, Jr., Southwest Grease and Oil Co., is vice president; Dr. J. V. Starr, Esso Standard Oil Co., is secretary and A. J. Daniel, Battenfeld Grease and Oil Co., is treasurer.

Elected to the board of directors were Mayor, S. C. M. Ambler, British American Oil Co.; T. W. Binford, D-A Lubricants Co.; E. W. Campbell, Gulf Oil Co.; R. Cubicciotti, L. Sonneborn Sons; A. G. Griswold, Cities Service Oil Co.; F. R. Hart, Standard Oil Co. (Calif.); C. L. Johnson, Jesco Lubricants Co.; W. A. Magie II of Magie Brothers Oil Co.; A. S. Randak of Sinclair Refining Co., and T. F. Shaffer of Shell Oil Co.

### Diesel Oil Created From Low-temperature Tar

The Central Fuel Research Institute, Jealgora, is investigating the manufacture of suitable grades of diesel oil by hydrogenating tar fractions of low-temperature carbonization.

Hydrogenation of untreated tar fractions distilled at 250-300 C. in a batch autoclave with a nickel-complex catalyst, developed at the institute, has produced a diesel oil of superior quality.

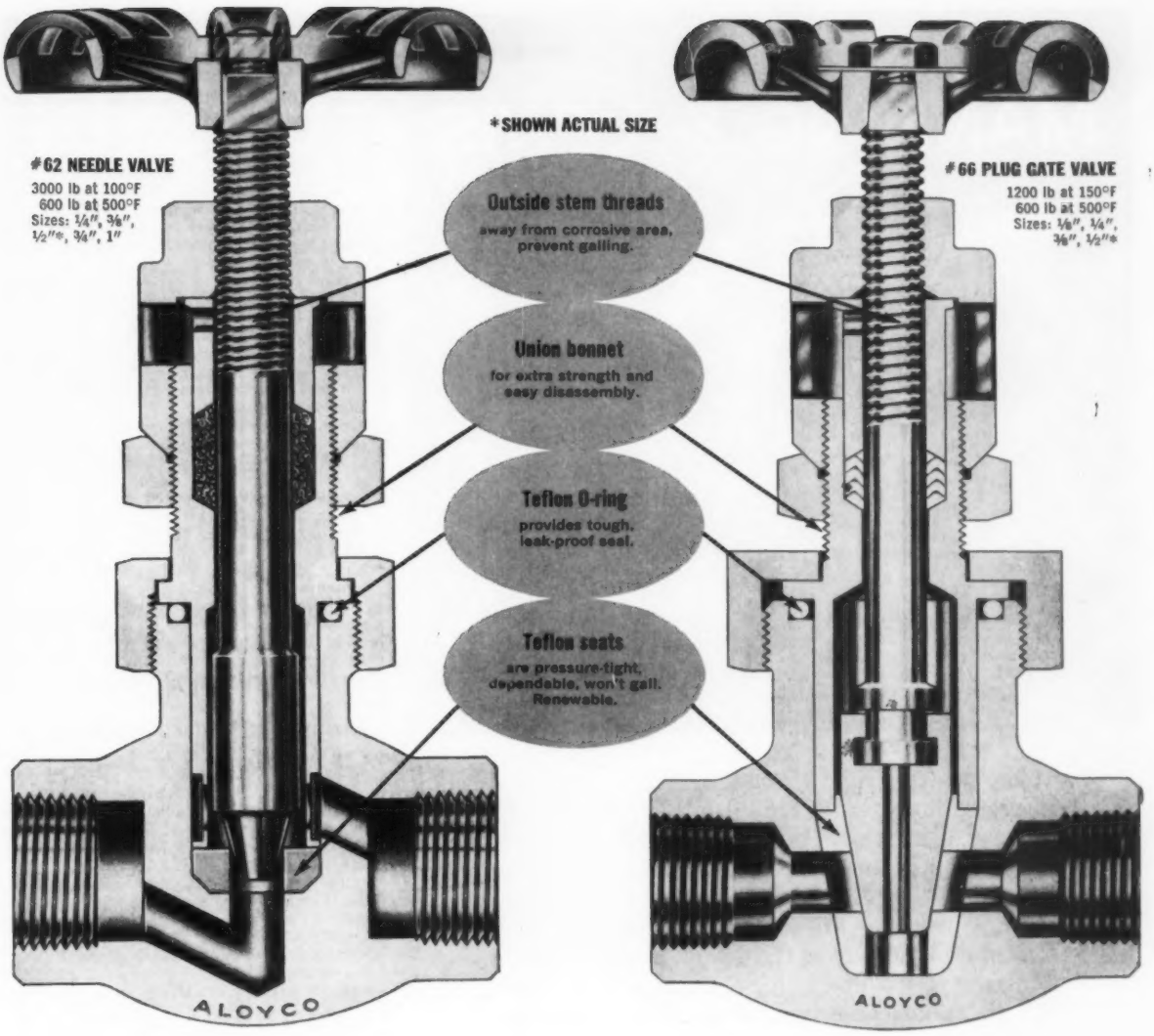
At a catalyst concentration of 10 per-

### Chemicals Wanted

The National Registry of Rare Chemicals, Armour Research Foundation, 33rd Federal and Dearborn Streets, Chicago 16, has received urgent requests for the chemicals listed below. If anyone has one or more, even if only one gram quantities, please inform the registry.

Cyclobutane
Benzenepentacarboxylic acid
1,2,3,5-Benzenetetracarboxylic acid (Prehnitic acid)
p-Chlorocumene
1-Chloro-2-methylbutadiene-1,3
2-Chloro-4-methylpentane
2,4-Dichloropentane
Dicobalto octacarbonyl
Dilauryl phthalate
3,3-Dimethyl-1-butanol
5,5-Dimethylheptene-3
N,N-Dimethyl phenylammonium iodide
2-Ethoxypropane
2-Ethyl-n-butyl chloride
4-Ethyl cyclohexanol
Furfuryl cyanide
N-Hexyl azide
2-Methyl-n-butyl chloride
Nonanol-5
Vinyl sulfide


For more data on advertised products, use Readers' Service Cards, last page.




# radically different ALOYCO Stainless Steel Valves eliminate leakage and galling common to ordinary fine control valves

Introduced eight years ago, these two small Aloyco valves have proved themselves in many types of severe corrosive service as well as handling hard-to-hold fluids and high-pressure gases.

The No. 62 Needle Valve (left) is particularly suitable for sensitive control of flow . . . as in metering or sampling for process plant, laboratory or pilot plant use.

The No. 66 Gate Valve has a vented, full-floating plug disc, which exerts no twisting action on the removable Teflon seat in closing. It is ideal for instrument lines, in small lines handling viscous liquids, or where a low pressure drop is important.

For more facts write to Alloy Steel Products Company, 1303 West Elizabeth Avenue, Linden, New Jersey... the one manufacturer specializing in Stainless Steel Valves exclusively.

9.4

**ALLOY STEEL PRODUCTS COMPANY** LINDEN, N. J.

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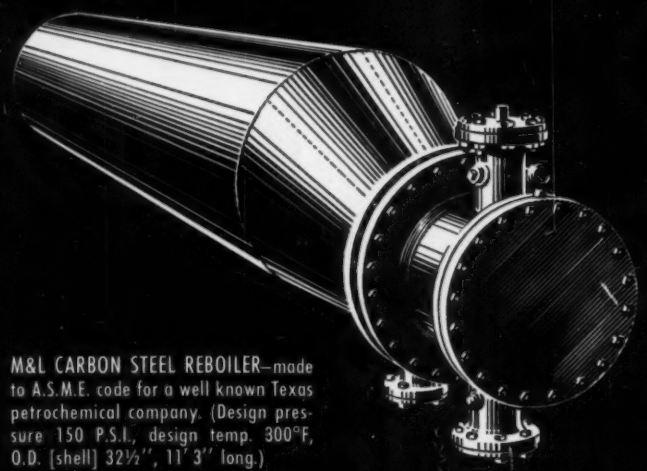
# MANNING & LEWIS



M&L CARBON STEEL REBOILER—made to A.S.M.E. code for a well known Texas petrochemical company. (Design pressure 150 P.S.I., design temp. 300°F, O.D. [shell] 32½", 11' 3" long.)

Today's rapid strides in the technology of processing plant operation make it essential for a manufacturer of equipment to be "staffed up" with people who have had extensive training and experience. More than half our staff have spent a major part of their working life in this one field and have played a major role in the design and fabrication of many types of processing equipment. They know the limitations and workability of all metals and how to get maximum service from each. This accumulated knowledge of base materials and our extensive experience in design and fabrication means practical, trouble-free equipment at the lowest possible cost.

It is impossible, in a field requiring such wide diversification, to illustrate, or even list, all the products we have been called upon to supply. The reboiler above is simply one among thousands.

*Call on us the next time you need equipment. We are fully qualified to design and fabricate to all codes.*

M&L MANNING & LEWIS

ENGINEERING COMPANY

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DESIGNERS & MANUFACTURERS OF QUALITY HEAT EXCHANGE EQUIPMENT


## What's Happening . . .

cent, a high initial pressure of oxygen and a temperature of 400 C., the conversion of tar acids and bases to hydrocarbons was almost quantitative, and the resulting products contained 72 percent of saturates.

With a progressive decreasing amount of catalyst and a temperature of 450 C., the yield and quality of oil was unsatisfactory, but the conversion of tar acids and bases was complete.

The conversion of tar acids in fractions distilled at 300-350 C. and hydrogenated at 400 C. was satisfactory, but the conversion of bases was incomplete. At higher temperatures a higher yield of oil boiling in the gasoline range (60-200 C.) with a corresponding decrease in diesel oil fraction was obtained.

Similar experiments have been conducted with neutral oil fractions of b.p. range 200-250, 250-300, and 350-400 C. with nickel-complex catalysts of varying composition and varying percentages of promoter. The yield of diesel oil from neutral oil (b.p. 200-250 C.) varied from 53.5 to 79.9 percent. With the fraction b.p. 250-300 C., a slightly higher yield was obtained.

A catalyst of 4 percent concentration of a metal sulfide of group VI of the periodic table produced 73 percent diesel oil (with 74 percent saturate) from the fraction b.p. 250-300 C.

## Members Vote Approval Of ASHAE-ASRE Merger

Merger of the American Society of Heating and Air-Conditioning Engineers and the American Society of Refrigerating Engineers has been voted for by members of the two societies.

The consolidated Society will be named the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE).

Each Society recorded a high total number of ballots with 93 percent of ASHAE and 73 percent of ASRE voting for the merger. The ASHAE ballots totaled 5,712 with 5,307 favoring and 405 opposing the merger. The ARSE members voted 3,516 for and 1,293 against the merger with a total of 4,809 ballots.

A two-third majority of the total vote was required to approve the merger. Ballots were cast following a long period of exploration, explanation and discussion.

## Report Air Cooled Processes Are Cheaper Than Water

In many refinery applications, even in locations where fresh water is plentiful, air cooling of some processes is more economical than conventional water cooling, John W. Thomas of Standard Oil Company of Ohio, reported at the annual AIChE Meeting.

In a paper, "Economics of Air Cooling in Refinery Installations Where Water is Plentiful," he described two air cooling installations in his company's refineries, one near Toledo, where 20 percent of the cooling and condensing is being done by air, and at the Lima refinery where the principal condenser in a cat cracker is air cooled.

Capital costs of the Lima installation were $108,070, compared with $140,118 for water cooling, a saving of $32,048, he said.

At the 60,000-bpd refinery near Toledo,



For more data on advertised products, use Readers' Service Cards, last page.

DU PONT *Petroleum Chemicals* NEWS

Number 94 in a Series of Bulletins for the Petroleum Industry

JANUARY-FEBRUARY 1959

# New Du Pont RP-2 adds 3-way salespower to gasolines

Now refiners and marketers can improve their gasolines with "Du Pont RP-2," another product of Du Pont research to improve performance of petroleum products.

**HOW RP-2 CAN SELL FOR YOU:** Sample advertising kit, prepared by Du Pont's Advertising Department, shows how the use of RP-2 can be advertised and create new excitement for your brand of gasoline.

RP-2 adds three distinct kinds of improvement to gasolines:

**Prevents Rust.** RP-2 "plates out" on metals, forming a barrier between the metal and any moisture that may be present in the gasoline. Thus rusting is prevented throughout the automobile fuel systems from gas tank to carburetor. Incidentally, RP-2 also offers the same protection at the refinery and in the fuel distribution system.

**Stops Carburetor Icing.** RP-2 prevents stalling during idling caused by ice formation on the carburetor throttle plate. Many gasolines need this protection when the temperature ranges from 22 to 55°F. and relative humidity exceeds 65%.

**Provides Detergent Action.** RP-2 has a positive detergent action which not only keeps new carburetors clean but gradually cleans the throttle plate and throat of carburetors which have become dirty through long use.

The above advantages add up to improved performance on the highway and better satisfied gasoline customers. As mentioned above, there are also economy advantages for the refiner in the rust-preventive characteristics of the additive in protecting storage and shipping equipment.

Another important property of RP-2 is that it contains phosphorus. This makes it especially attractive to refiners already using phosphorus compounds for control of surface ignition. Thus, by taking a "phosphorus credit" the cost of protection against rust, carburetor icing and carburetor deposits is appreciably reduced.

While it has been widely adopted for use in motor gasolines, RP-2 is also an excellent rust preventive for aviation gasoline. And it is particularly interesting for jet fuel because, in some cases, rust preventing dosages also improve the CFR fuel coker ratings of the fuel.

Write for technical information.

## "It Never Rains Oil" depletion movie still playing to packed houses

The story of petroleum is still "big box office" around the country.

Probably one of the best signs of this is the continued success of "It Never Rains Oil," the full-color cartoon movie that tells the story of oil exploration, consumption and *depletion*.

Year after year, the film plays to capacity audiences of civic organizations, clubs, service station operators, and other groups in which opinion is formed.

It shows how oil is bringing better things into all our lives—from paints to pants, from synthetic rubber to better lubricants.

### Explains need

The movie goes on to show the dramatic search for oil—and the tremendous odds that face the searchers – as well as the growing consumption that makes an ever wider search necessary. It explains the government's recognition of the great cost of the search, in the form of a percentage depletion allowance. The film explains why this tax relief is desirable, necessary and fair.

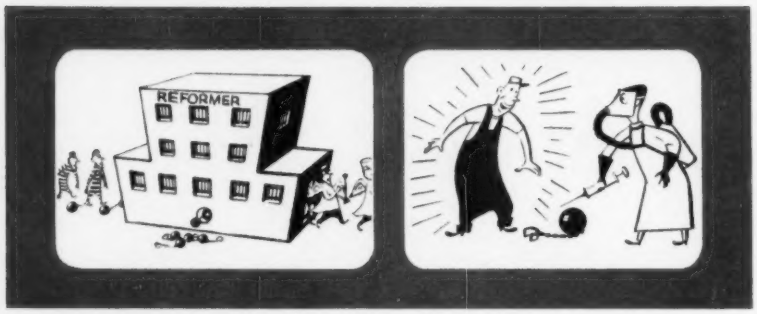
### Promotes better understanding

After viewing "It Never Rains Oil," audiences often report that they have a new, more appreciative viewpoint of what the oil industry is accomplishing. They better understand its problems and plans. If you would like to arrange showings, simply write, telling us when you would like to borrow the film and how long you would like to have it.

*ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)*

# DU PONT *Petroleum Chemicals* NEWS

## "Good Gasoline" movie goes before cameras a second time — for a new, modern look




**MOVIE SHOWS HOW** reforming (left) and addition of TEL (right) turn "bad" hydrocarbon molecules into good ones to prevent knock.

"What Makes Today's Gasoline Good" —the Du Pont sound-and-color movie that's been a hit with refiners and dealers for a number of years—has had its face lifted.

Writers, directors, actors and camera crews have been hard at work for the past several months, bringing it up to date.

The story line has changed, but the primary message remains as it was, a description of how refiners use cat-cracking, reforming, and tetraethyl lead and other additives to give gasoline the right qualities for good engine performance.

It compares "regular" and "premium" grades of gasoline, and uses amusing cartoon characters to explain knock, vapor lock, the reasons for seasonal blends, and other important aspects of gasoline.

The movie is perhaps one of the fastest, most memorable ways of showing and convincing service station operators (and even refinery employees) that much more goes into a gallon of gasoline than the average motorist realizes. Enthusiasm is created, along with improved sales-consciousness, when the picture is shown at dealer meetings.

Showings of the Du Pont movie can be easily arranged through your Du Pont representative, or by writing direct to Wilmington.

## YOU OUGHT TO KNOW...

ROBERT M. GLOVER was recently appointed Manager, Sales Programs, in the Petroleum Chemicals Division of the Du Pont Company, a position he assumed after vacating the office of Assistant Sales Manager. There his chief interest was tetraethyl lead sales combined with administrative duties concerned with manpower in the five regions of the division.

Mr. Glover brings to his new position a wealth of experience also in the petroleum additives field, where he has helped Du Pont customers solve a wide variety of blending and marketing problems.

At one time, Mr. Glover served as Manager of the Du Pont Petroleum Chemicals Division's Mid-Continent Region, with headquarters in Tulsa. In that capacity, he served all Du Pont customers in the area with the complete Du Pont line from tetraethyl lead to the most specialized additives.

## Winter freeze gets a cold shoulder from pipe that's made from oil

"If winter comes, can the plumber be far behind?" might be the modern version of one of the poet Shelley's famous lines.

It *might*, but the oil industry is changing all that. No longer does the freezin' season mean that pipes must freeze up and be repaired. In industry, the use of "Alathon"* polyethylene resin pipe is eliminating this costly and often dangerous problem.

Pipe of "Alathon" is made of a plastic based on petroleum. Its most remarkable quality is its flexibility. Instead of freezing and bursting, it simply expands. Even at 40° below zero, this pipe can be bent around corners.

Another advantage is its extreme light weight. Its corrosion resistance and its lack of odor and taste are bonus advantages.

"Alathon" polyethylene resin is the same material from which literally millions of squeeze bottles of cosmetics and many other products are made every year.

This is one further example of the growing contributions of *oil* in bringing better living to more people, through chemistry.

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**Los Angeles 17**—612 So. Flower St. MAdison 4-1354
**New York 20**—45 Rockefeller Plaza . . . . . COlumbus 5-2342
**Philadelphia 2**—3 Penn Center Plaza . LOcust 8-3531
**Pittsburgh 22**—1 Gateway Center . . . ATlantic 1-2933
**San Francisco 4**—111 Sutter St. . . . EXbrook 2-1934
**Seattle 3**—4003 Aurora Ave. . . . . MElrose 2-6977
**Tulsa 1**—1811 So. Baltimore Ave. . . . LUther 5-5578
**In Canada**—Du Pont of Canada Limited, Petroleum Chemicals, 85 Eglinton Ave. East, **Toronto 12**—Ontario . . . . . HUdson 1-6461
**OTHER COUNTRIES:** Petroleum Chemicals Division, Export Sales, Wilmington 98, Delaware, PRospect 4-2962.

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***. . . through Chemistry***

## Du Pont Tetraethyl Lead and other Petroleum Additives

*ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)*

A-8654

Printed in U. S. A.

11 units are air cooled. These included a crude and vacuum unit, a delayed coker, a cat cracker, a hydrogenation unit, a cat reformer, a cat poly plant and treating plants. The plant is adjacent to an older 20,000-bpd refinery, utilizing 20,000 gallons per minute of lake water for cooling and condensing. A study showed that the existing water line to the lake was not large enough for the additional cooling requirements for the new plant. It also showed that an additional cooling tower was cheaper than building a new line to the lake. It was decided to use air cooling on the 11 units. Not enough of this equipment was installed for all purposes, however, so water also was used, but a "real saving in cooling tower and water piping" resulted from a resulting reduction in cooling tower size.

"It must be appreciated," he said, "that if the circumstances are such that the installation of air coolers will eliminate the need of adding a cooling tower, a capital cost comparison will be weighted very much in favor of the air cooler."

Total estimate cost of water cooling facilities for the 11 services was $410,000. The cost for air cooling facilities was $500,000, but the operating costs of the air cooled units was $65,500 less per year than for water coolers, a 74 percent saving, he said.

"Air cooling has a decided place in the process industry," he concluded. "Even in locations where water is plentiful there are many services where air cooling is lower in initial cost than water cooling. In addition, operating costs of air cooling are far lower than operating cost associated with water cooling."

## Murphree Says Engineers Helping Beat Inflation

Better design and improved processes have cut new refinery equipment costs by about five percent a year according to Eger V. Murphree, president of Esso Research & Engineering Co. "This has more than taken care of the forces of inflation so that, over the years, on an actual dollar basis, the cost of new equipment to do a given job has decreased," he said.

In a talk before the ASME, Murphree said drilling costs have been reduced two to three percent due to better engineering. He added that new techniques may help to double the nation's present and potential petroleum reserves, and may be useful in developing oil shale and tar sands production.

## Propylene Doesn't Harm LPG Fuel, Says NGAA

The claim that propylene in propane has been the cause of knocking, burned valves, and other destructive results to engines using LP-Gas as fuel has been discredited by a series of full scale engine tests conducted during the past summer, according to the Natural Gasoline Association of America. The organization's LP-Gas committee ran the tests on several widely used makes of bus and tractor engines with fuels ranging from pure propane to 47 percent blends of propylene and propane.

The tests reportedly proved conclusively that the engines which had been experiencing trouble will have the same trouble and knock on 100 percent pure propane,


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INERT GAS
GENERATOR

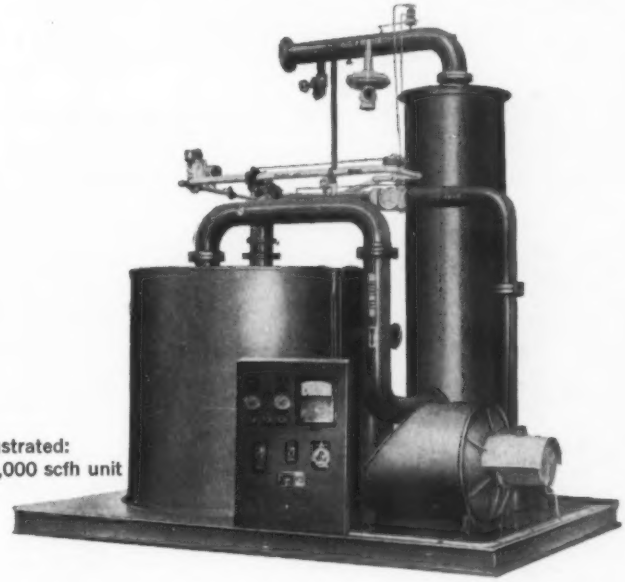
utilizes unique principles of design to provide refineries, chemical processors, metallurgical plants and other industrial users with a source of inert or purge gases that is compact in size . . . highly efficient . . . extremely economical to operate.

SUBMERGED EXHAUST OF COMBUSTION PRODUCTS

makes feasible the use of low-cost river or contaminated water as coolant. The tank of water through which the gases pass provides an unusual degree of safety to prevent flash-back between the burner and the process.

REFRACTORY IS ELIMINATED

and maintenance costs reduced through the use of the high heat release THERMAL burner which can be fired with either gas or distillate oil. Units are supplied as complete packages and include all control and safety equipment. Standard models will produce up to 60,000 SCFH of inert gas; larger capacity units can be designed to meet your specifications.



Illustrated:
50,000 scfh unit

FOR DETAILED INFORMATION
WRITE FOR BULLETIN #114

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REPRESENTATIVES IN PRINCIPAL CITIES

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For more data on advertised products, use Readers' Service Cards, last page.

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Handling fluids at sub-zero temperatures or at super-heat – or any of the temperatures in between – is no problem if you install Powell valves. There is a Powell Dependable Valve to meet your most exacting flow-control requirements, no matter what the extremes of your needs.

The complete Powell line includes all types of valves in bronze, iron, steel and corrosion resistant metals and alloys, for pressures from 125 to more than 2500 pounds W.P. Consult your local distributor (there's one in most major cities) or write to:

**The Wm. Powell Company • Cincinnati 22, Ohio**

*Dependable Valves Since 1846*

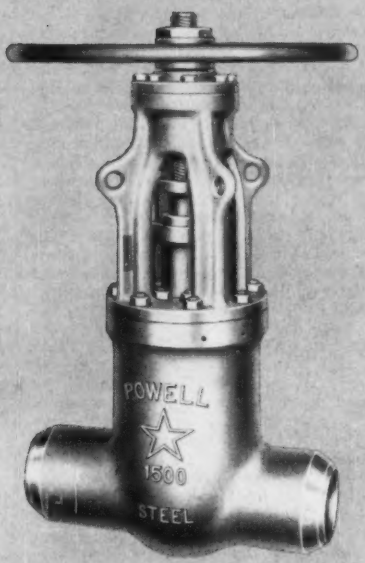


Fig. 11303 W. E.: Steel O. S. & Y. pressure seal gate valve for 1500 pounds W. P. at high temperatures. Powell pressure seal valves are available for working pressures from 600 through 2500 pounds.

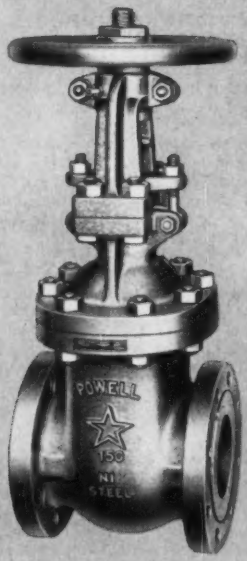


Fig. 1503 Mod.: 3½% Nickel-steel O. S. & Y. gate valve for low temperature service.

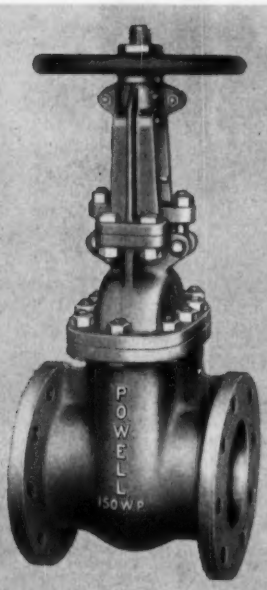

Fig. 86190: Steel union bonnet globe valve for 400 W.O.G. Designed for liquified petroleum gas service.

Fig. 2453G: Large 150 pound stainless steel O. S. & Y. gate valve for low temperature service. Can be furnished with interchangeable solid or double wedge disc.

**POWELL...world's largest family of valves**



For more data on advertised products, use Readers' Service Cards, last page.

## What's Happening. . .

and that other engines, of better design, will not have trouble or knock with propane containing up to 50 percent butane or up to 47 percent propylene.

The tests were run because of widely circulated statements early in 1958 that some engine manufacturers were discontinuing LP-Gas engines due to difficulties with the fuels. These statements were so disturbing to producers of the products, that NGAA began immediate research on the subject.

### API Centennial Committee Will Offer Literature

Plans and preparations for the oil industry's centennial celebration are coming to a head rapidly, and it appears that this will be a standout year in petroleum's history.

A special API Centennial committee has been working on the anniversary for some time. Although the API itself will function as a "service" organization, it also will produce a variety of materials to help oil men and oil companies observe the anniversary. All are keyed to the Centennial slogan—"Oil's First Century—Born in Freedom, Working For Progress."

Among items to be available are a Centennial History, brochures, leaflets, pamphlets, press and editorial materials, advertising aids, etc.

The centennial director coordinating the industry plans is **W. R. Huber**, former director of public relations for Gulf Oil Corp., Pittsburgh.

### Argentina API Organized, Appoints Officers for 1959

Instituto Argentino Del Petroleo, the "API of Argentina," has been organized and has appointed officials for 1959. They are:

Bernardo Rikles, president; Dr. Altavino E. Catinari, vice president; Joe F. Soler, secretary; Martin T. Aranguren, assistant secretary; Edgardo Rambelli, treasurer; and Emilio Begher, assistant treasurer.

### Maintenance-Engineering Conference Has New Topics

The tenth year of the Plant Maintenance & Engineering Conference will feature speakers from 19 states and Canada. The men are from a diversity of industries.

The conference will occur during the Plant Maintenance & Engineering Show, Cleveland, January 26-29. Almost one-third of this year's topics are new. Industries that will get special attention are nuclear products, abrasive products, metal working and fabricating, assembly plants, chemical, electrical manufacturing, petroleum processing, pulp and paper, foundries, and research and development laboratories. Twenty of the sessions will consider general problems affecting all plants. Among the more urgent problems to be considered this year is the matter of air and water pollution.

**Now Turn the Page and Read Changing Times**

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## —Changing Times—

**American Petrofina, Inc., has purchased Reco Oil Co.,** consisting of producing properites and oil and gas reserves in Colorado, Nebraska and Oklahoma.

Michel Halbouty, Houston independent oil man, predicted upon return from three-week tour of Alaska, that **"one major discovery there will probably open the biggest petroleum boom of modern history."** Halbouty controls 1.25 million acres in Alaska.

Husky Hi-Power Inc., has established a company record of two years without a lost-time accident. **The Husky Oil Co. subsidiary recorded 450,000 man hours without an accident causing a man to leave work.**

New company, **Constock-Pritchard Liquification Corp., has been formed** by J. F. Pritchard and Co., Continental Oil Co., and The Union Stock Yard and Transit Co. It will **construct, design and develop gas liquification plants.**

**Atlantic Refining Co. has loaded its first cargo of crude at newly-completed Punta de Palmas terminal** on west side of Lake Maracaibo, Venezuela. Shipment of 135,000 barrels went to company's Philadelphia refinery.

**Tidewater Oil Co. plans to spend $100 million for the 1959 fiscal year,** same as the company's outlay in 1958. Seven-year expansion program for Tidewater will account for $831 million by December 31.

**Queen Frederika of Greece has christened tanker Princess Sophie,** named after her daughter. **Gigantic ship compares in size to world's largest ocean liners.** It is 859 feet long and 115 feet wide—holds 70,700 long tons or 27 million gallons.

**New Blaw-Knox affiliate has been formed**—Blaw-Knox Chemical Engineering Co. Ltd., London. **Firm will serve and develop overseas markets for engineering and construction** of all types of processing plants. Job was formerly done by Chemical Plants and Buflovak divisions.

**J. F. Pritchard and Co. has formed the Constock-Pritchard Liquefication Corp.,** with headquarters in New York. **Company will build, develop and design plants for all phases of gas liquefication.**

American Petrofina Co. is using **mobil service station in Oklahoma City.** Unit, 10½ x 6 feet, **has all features of regular station except lube and wash.** It has 300-gallon capacity, weighs 3,000 pounds full, 1,100 pounds empty—**operates on 36-volt D.C. battery.**

**Humble Oil & Refining Co. has processed 2 billion barrels of crude oil at its Baytown, Texas, refinery.** First crude went to stills in May, 1920. Company says this is **enough crude to supply U. S. needs for 200 days.**

**Socony Mobil Oil Co. tankers are equipped with new signal lights that project rays in every direction** and at 45 degree angle visible all around horizon. Amber light **can be seen seven miles in clear weather,** turns on automatically when whistle is blown. Signal has 300-watt, 70,000 candlepower lamp.

**Tidewater Oil Co. has moved world headquarters to new $10 million building in Los Angeles.** Move coincides with company's 80th anniversary. Company's 400 employes will move from San Francisco.

**Cosden Petroleum Corp. has acquired all assets of Pratt-Hewit Oil Corp. and its Texas subsidiary,** Pratt-Hewit Oil Corp. of Texas. Deal involves producing and non-producing oil and gas leases in South Texas.

**Ethyl Corp. is using truck trailer bodies that can be taken aboard ship for offshore deliveries.** New method involves trailorized tanks with capacity equal to 40 standard 55 gallon drums. **They are unloaded in one hour,** compared with six hours for handling 40 drums.

**Ten specifications for metal drums and pails ranging from 5 to 55 gallons has just been published as American Standards by ASA.** Set is available for $1.00 from ASA.

**Sale of Universal Oil Products Co. by its trustee, Guaranty Trust, New York, may proceed** subject only to court referee's approval of terms and conditions.

**Petroleos Mexicanos is seeking $60 million loan from U.S.** Part of money would finance pipeline from Ciudad Pemex to Mexico City. Interest of **5.5 percent is involved.**


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AND DOUBLE THE NUMBER YOU FIRST THOUGHT OF

**A lining lasts as long as its bonding properties.**

The natural organic bond of refractory clays and the chemical set of concrete all fail eventually under the stresses imposed upon them. When a lining is "bonded" or given "bone" by Hexmetal Reinforcement, it holds in position long after all its natural bond is burnt out by heat or chemical action. The independent pinned joint of Hexmetal cells give twice the life of other reinforcements with lug joints.

*Industry is year by year proving the value of these claims in Flues, Ash-Pits, Reactors, Cyclones, Cat Crackers, Coke Hoppers, Down Comer Pipes, Hydroformers, Water Turbine Flumes, Underground Galleries, etc.*

*Write or telephone for fullest details.*

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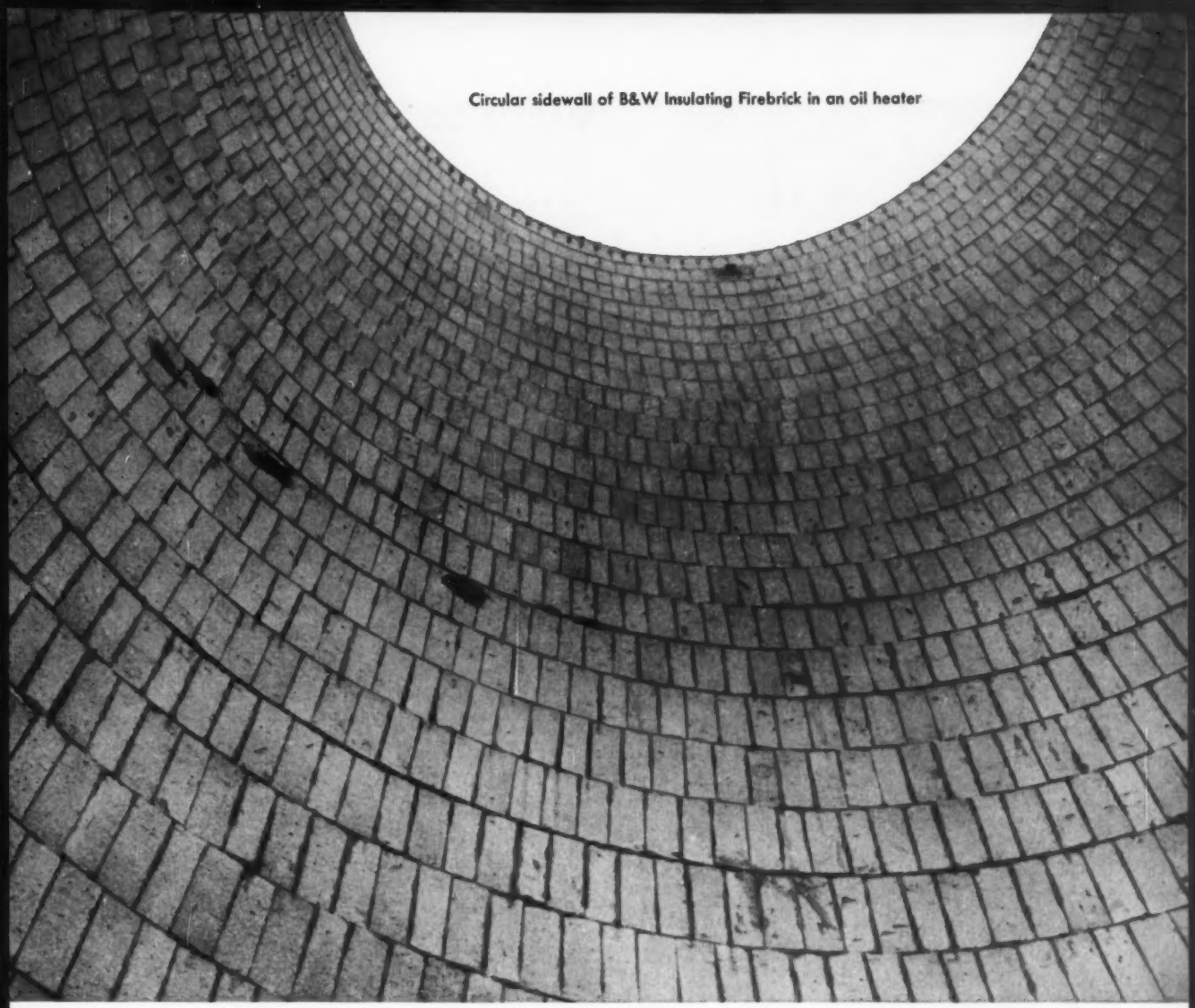
*CABLES: Hexmetal, London.*



Circular sidewall of B&W Insulating Firebrick in an oil heater

# How B&W Insulating Firebrick cut processing costs

Here are four *key* reasons why B&W Insulating Firebrick reduce over-all costs in chemical and petroleum process furnaces:

**High Hot Load Strength** —B&W IFB provide maximum load-bearing capacity *under operating temperatures.* Many oil heaters have been built with walls 80 feet high *with no intermediate support.*

**Low Heat Storage** — Cost-cutting B&W IFB have the *lowest* heat storage of any insulating firebrick. Since B&W IFB cool off fast, they protect expensive alloy tubes in the event of forced shut-down . . . make possible quick access to the furnace for inspection. They also reach operating temperature quickly, reducing cycle time and fuel bills.

**Long Life** — B&W Insulating Firebrick are *long* lasting because of the exceptional refractory nature of their base ingredients and the high processing temperatures to which they are subjected during manufacturing.

**Short Installation Time** —You save materially with B&W Insulating Firebrick because they are machined to size. They may be modified to fit door openings, peepholes, and other special conditions because they can be cut, drilled or shaped on the job with ordinary woodworking tools.

These sound reasons explain why process furnace builders and operators specify B&W Insulating Firebrick. Learn how these lightweight brick can help you save money. Your B&W representative will be glad to give you facts and figures.

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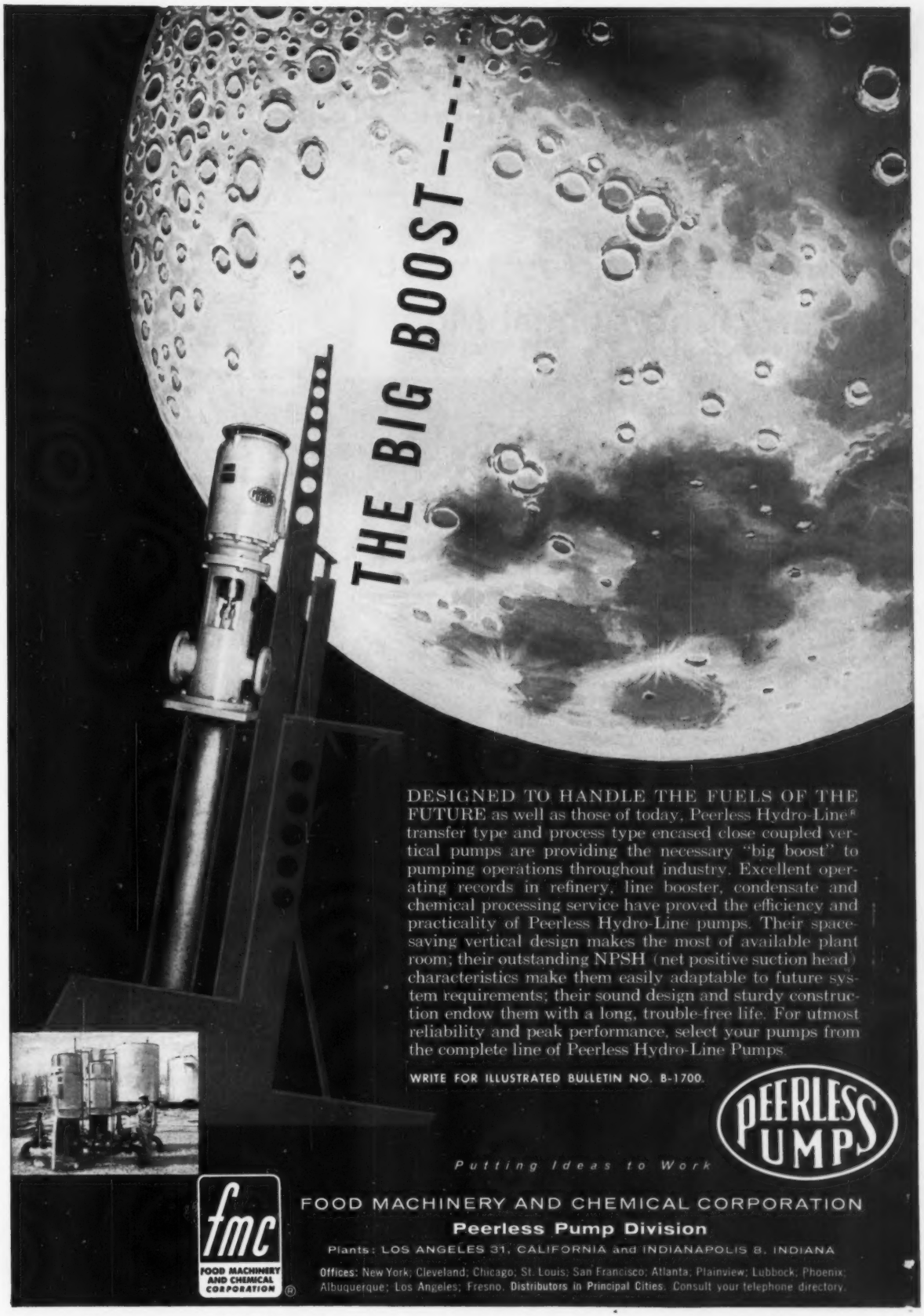
# MEETINGS CALENDAR

| | |
|---|---|
| JAN. 1959 | |
| 21-22 | Western Petroleum Refiner's Association, Gulf Coast Technical-Industrial Relations Meeting, Ben Milam Hotel, Houston. |
| 22-23 | American Chemical Society, Third Symposium on Hydrocarbon Chemistry, Shamrock Hilton Hotel, Houston. |
| 22-23 | National Association of Corrosion Engineers, Houston Section, Houston Short Course of Corrosion Control, University of Houston. |
| 23 | Natural Gasoline Association of America, Oklahoma Regional Meeting, Biltmore Hotel, Oklahoma City. |
| 25-27 | American Society of Lubrication Engineers, Gear Symposium, Hotel Morrison, Chicago. |
| 26-27 | American Society for Engineering Education, University of Houston. |
| 26-29 | Plant Maintenance and Engineering Show, 10th Annual Show, Public Auditorium, Cleveland. |
| 28-29 | Midwest Welding Conference (Armour Research Foundation and Chicago Section of American Welding Society) at Illinois Tech, Chicago. |
| FEB. | |
| 2- 6 | American Society for Testing Materials, Committee Week, William Penn Hotel, Pittsburgh. |
| 5- 6 | Industrial Management Engineering Conference, Sponsored by Illinois Institute of Technology and Armour Research Foundation, Chicago. |
| 9-13 | American Society of Civil Engineers, National Convention, Los Angeles. |
| 11-13 | National Association of Corrosion Engineers, Western Regional Meeting, Calgary, Alberta. |
| 15-19 | American Institute of Mining Engineers, Annual Meeting, Sir Francis Drake Hotel, San Francisco. |
| 26-27 | American Petroleum Institute, Division of Marketing, Lubrication Committee Meeting, Sheraton-Cadillac Hotel, Detroit. |
| 27 | Natural Gasoline Association of America, Permian Basin Regional Meeting, Schorbaur Hotel, Midland, Texas. |
| MAR. | |
| 1- 5 | American Society of Mechanical Engineers, Gas Turbine Power Conference and Exhibit, Netherlands-Hilton Hotel, Cincinnati. |
| 6- | Natural Gasoline Association of America, Gulf Coast Regional Meeting, Robert Driscoll Hotel, Corpus Christi. |
| 8-12 | American Society of Mechanical Engineers, Aviation Conference, Statler Hotel, Los Angeles. |
| 9-11 | Midwest Gas Association, Annual Meeting, Hotel Fort Des Moines, Des Moines. |
| 13 | American Institute of Chemical Engineers and American Chemical Society, 6th Annual Joint Technical Meeting, Beaumont, Texas. |
| 16-18 | Western Petroleum Refiners Association, 47th Annual Meeting, Hilton Hotel, San Antonio. |
| 16-20 | National Association of Corrosion Engineers, 1959 Corrosion Show and 15th Annual Conference, Sherman Hotel, Chicago. |
| 16-20 | American Society for Metals, et al, 11th Western Metal Exposition and Congress, Pan-Pacific Auditorium and Ambassador Hotel, Los Angeles. |
| APRIL | |
| 5-10 | Instrument Society of America, Nuclear Congress, Cleveland Auditorium, Cleveland. |
| 5-10 | American Society of Mechanical Engineers, Nuclear Congress, Cleveland Auditorium, Cleveland. |
| 5-10 | American Chemical Society, 135th National Meeting, Boston. |
| 6- 7 | Instrument Society of America, 2nd Annual Symposium on Chemical & Petroleum Instrumentation, St. Louis. |
| 13-17 | The 29th Annual Safety Convention & Exposition, Hotel Statler, New York. |
| 14-16 | Southwestern Gas Measurement Short Course, Drill Hall, North Campus, University of Oklahoma. |
| APRIL | |
| 15-17 | National Petroleum Association, Semi-annual Meeting, Hotel Cleveland, Cleveland. |
| 19-23 | American Society of Mechanical Engineers, Oil and Gas Power Conference and Exhibit, Shamrock-Hilton Hotel, Houston. |
| 21-23 | American Society of Lubrication Engineers, Annual Meeting and Exhibit, Hotel Statler, Buffalo, N.Y. |
| 22-24 | Natural Gasoline Association of America, 38th Annual Convention, Baker and Adolphus Hotels, Dallas. |
| 29-30 | Western Petroleum Refiners Association, Southwest Regional Technical-Industrial Relations Meeting, Hotel Paso del Norte, El Paso. |
| MAY | |
| 3- 6 | Liquified Petroleum Gas Association, Annual Meeting, Conrad Hilton Hotel, Chicago. |
| 4- 5 | American Society of Mechanical Engineers, Maintenance and Plant Engineering Division Conference, Edgewater Beach Hotel, Chicago. |
| 4- 6 | American Petroleum Institute, Division of Marketing, Lubrication Committee Meeting, San Marcus Hotel, Chandler, Ariz. |
| 4- 8 | American Petroleum Institute, Safety and Fire Protection Committees, 12th Midyear Meeting, Rice Hotel, Houston. |
| 5- 7 | Purdue University's 14th Annual Industrial Waste Conference, Purdue Memorial Union Building, Lafayette, Ind. |
| 14-23 | International Petroleum Exposition, Tulsa. |
| 18-20 | Instrument Society of America, 5th Annual Symposium on Instrumental Methods of Analysis, Shamrock-Hilton Hotel, Houston. |
| 27-29 | American Petroleum Institute, Division of Marketing, Midyear Meeting, The Savery Hotel, Des Moines. |
| 27-30 | American Petroleum Institute, Division of Refining, Midyear Meeting, Statler Hotel, New York. |
| JUNE | |
| 1- 5 | Fifth World Petroleum Congress Exposition, New York Coliseum, New York. |
| 10-12 | Instrument Society of America, 2nd International Symposium on Gas Chromatography, East Lansing, Mich. |
| 14-19 | Society of Automotive Engineers, Summer Meeting, Chalfonte-Haddon Hotel, Atlantic City. |
| 21-26 | American Society for Testing Materials, Annual Meeting, Chalfonte-Haddon Hall, Atlantic City. |
| 24-25 | Western Petroleum Refiner's Association, Mid-Continent Technical-Industrial Relations Meeting, Broadview Hotel, Wichita. |
| AUG. | |
| 10-13 | Society of Automotive Engineers, National West Coast Meeting, Hotel Georgia, Vancouver, B.C. |
| SEPT. | |
| 9-10 | American Society of Mechanical Engineers, 2nd International Congress on Air Pollution, New York. |
| 13-18 | American Chemical Society, 136th National Meeting, Atlantic City. |
| 21-23 | American Society of Mechanical Engineers, Petroleum Conference, Rice Hotel, Houston. |
| 21-25 | Instrument Society of America, 14th Annual Instrumentation-Automation Conference and Exhibit, International Amphitheater, Chicago. |
| 23-24 | Western Petroleum Refiner's Association, Rocky Mountain Technical-Industrial Relations Meeting, Henning Hotel, Casper. |




DESIGNED TO HANDLE THE FUELS OF THE FUTURE as well as those of today, Peerless Hydro-Line® transfer type and process type encased close coupled vertical pumps are providing the necessary "big boost" to pumping operations throughout industry. Excellent operating records in refinery, line booster, condensate and chemical processing service have proved the efficiency and practicality of Peerless Hydro-Line pumps. Their space-saving vertical design makes the most of available plant room; their outstanding NPSH (net positive suction head) characteristics make them easily adaptable to future system requirements; their sound design and sturdy construction endow them with a long, trouble-free life. For utmost reliability and peak performance, select your pumps from the complete line of Peerless Hydro-Line Pumps.

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FOOD MACHINERY AND CHEMICAL CORPORATION

**Peerless Pump Division**

Plants: LOS ANGELES 31, CALIFORNIA and INDIANAPOLIS 8, INDIANA

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**VISIT WITH US DURING THE I.P.E. — BOOTHS 11 & 12 OKLAHOMA BUILDING**

# What's Happening . . .

## . . . *Among Men* in the Industry

## Katz, McAfee Elected to Top Posts at AIChE Annual Meet

Dr. Jerry McAfee

Dr. Donald L. Katz

**Dr. Donald L. Katz,** of the University of Michigan, was elected president of AIChE at the organization's 51st Annual Meeting. He is head of the Department of Chemical and Metallurgical Engineering at Michigan, and is an industrial consultant and technical author. Dr. Katz is co-author of a recent book, "Fluid Dynamics and Heat Transfer," and of a handbook on natural gas engineering which is being published this month. Author of many excellent articles for PETROLEUM REFINER, he has B.S., M.S., and Ph.D. degrees from Michigan.

**Jerry McAfee,** vice president of Gulf Oil Co., was elected AIChE's vice president. He has been with Gulf since 1945 when he was named chemical engineer in charge of pilot plant operations. Before that he had been a chemical engineer with Universal Oil Products Co. McAfee has B.S. degree in chemical engineering from The University of Texas and a D.Sc. degree in chemical engineering from Massachusetts Institute of Technology. Other new officers elected were:

**Dr. J. Henry Rushton,** Purdue University, treasurer; and **F. J. Van Antwerpen,** Nutley, N. J., secretary.

Elected directors for three years were: **W. R. Collings,** president, Dow Corning Co.; **W. B. Franklin,** head, Technical Service division, Humble Oil Co., Baytown, Texas; **L. C. Kemp, Jr.,** vice president, The Texas Co.; and **Roland Voorhees,** associated technical director, Union Carbide Development Co.

**Benjamin G. Symon,** formerly industrial products manager of Shell Oil Co., has been named vice president of International Lubricant Corp., New Orleans. He has been a director of the corporation for several years, and was recently made general sales manager. Symon, a mechanical engineering graduate from the University of Missouri, joined Shell in 1928 as assistant to the manager, Lubricants department, St. Louis. In 1940 he moved to New York as manager of the Technical Products department and was named manager of the Lubricants department two years later. He was named manager of Shell's Industrial Products department in 1955. Symon is an active member of API, NPA, and ASLE.

**E. E. Aine** has been named superintendent of The Texas Co.'s Los Angeles works. Formerly assistant superintendent, he succeeds **W. J. Ryan,** who will retire. **George Louis,** supervisor of the Crude Still area, Los Angeles works, succeeds Aine as assistant superintendent there.

**W. A. Myers** has been named acting manager of the Research and Development department, The Atlantic Refining Co. He joined the department in 1927 and has served as assistant general manager since 1947.

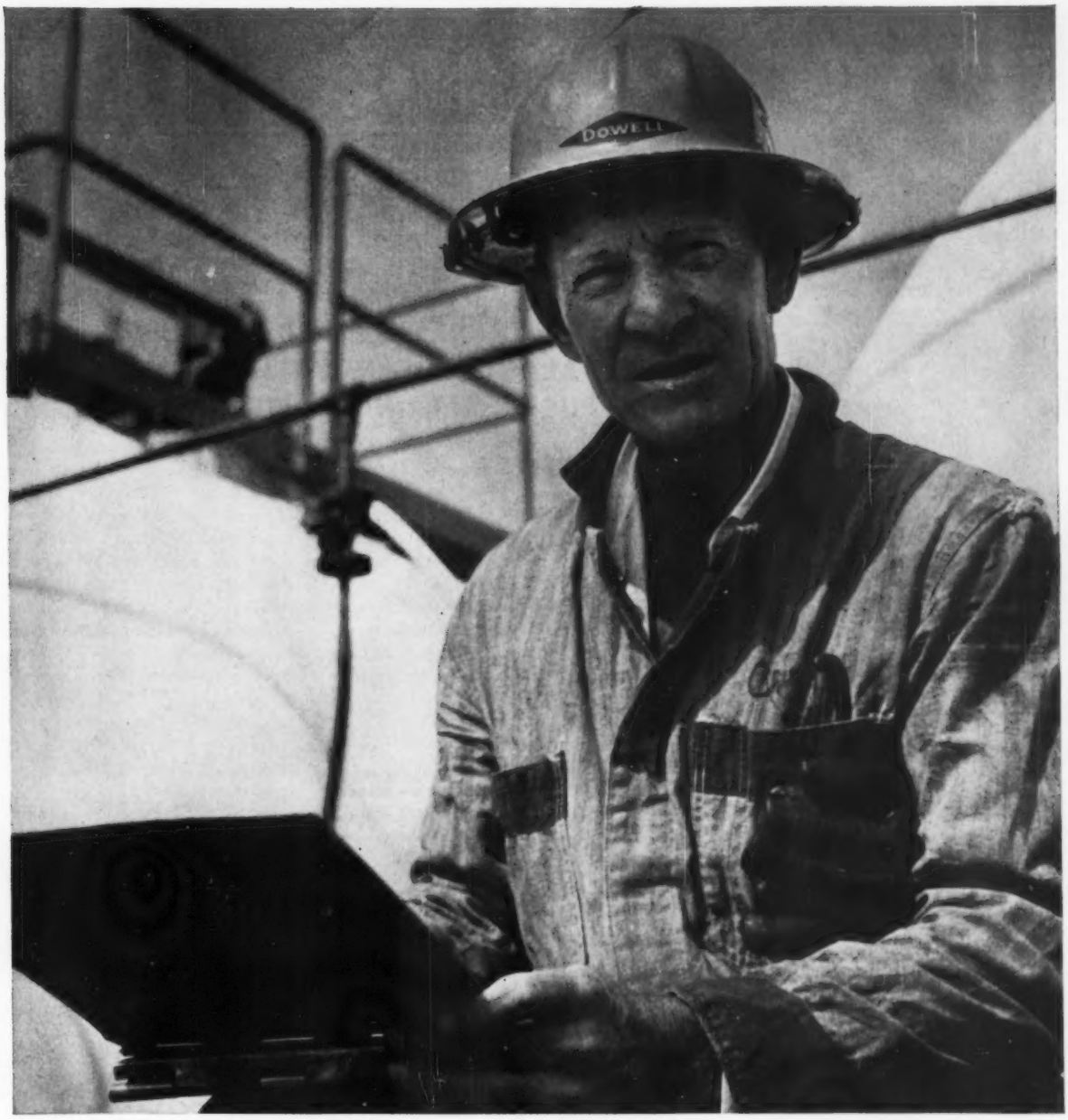
**Wilfred M. Kluss** has been named assistant to the general manager of the Marine Transportation department, Socony Mobil Oil Co., Inc. Before assuming his new position, he was senior area executive in the department of Middle Eastern affairs. He came to the company in 1954 from the International Bank for Reconstruction and Development. Kluss graduated from Harvard University in 1942.

**Brook I. Smith** has been appointed a senior engineering associate by the Executive committee, Esso Research and Engineering Co. With Esso Research over 30 years, he began his company career after receiving a B.S. degree in mechanical engineering from Purdue University. He spent five years with Esso Research—then returned to Purdue for his M.S. degree in chemical engineering. He is a member of the Chemicals Development division where his work deals with planning in the petrochemicals field and working with overseas affiliates of Standard Oil Co. (N. J.).

**Dr. Ellis K. Fields** has been named a research associate, Whiting Research laboratories, Standard Oil Co. (Ind.) Previously a group leader there, he has carried out research in the organic chemistry of petroleum compounds. His new research will be on petrochemicals, plastics and fibers. Dr. Fields has a Ph.D. degree in chemistry from the University of Chicago, where he also completed undergraduate study.

**Jerry Luboviski** has become director of public relations and advertising for Union Oil Co. of Calif. He had been manager of public affairs for the company. A former Southern California newspaperman, Luboviski had been manager of public relations for the Western Oil and Gas Association before joining Union.

**Dr. E. O. Barstow** and **R. L. Curtis** have retired from the board of directors, The Dow Chemical Co. Barstow also retired as vice president but was named honorary chairman of the board, and is expected to attend many of its meetings in an advisory capacity. Curtis also retired as general manager of Dow's Western division but retains a vice presidency and will re-




## This Man Can Mean Extra Profit For You

This is a Dowell Service Engineer. He is an expert in the use of chemical solvents to remove scale and sludge from your process systems, boilers, tanks and piping.

Using the exclusive Dowell methods of chemical cleaning, this engineer can free up the profits that these deposits cut from your operating ledger.

More than 15 years experience in all industries—for example, oil refining, chemical, steel, public utilities and paper—give Dowell engineers full knowledge of the problems of cleaning plant equipment.

Add to this experience the benefits you get in special equipment, chemicals, research and trained people.

Put this ability and experience to work for you. Let the Dowell man engineer a profitable chemical cleaning program for you. Dowell—the largest, the oldest, the most experienced chemical cleaning service—Tulsa 1, Oklahoma; and 165 stations and offices in major industrial centers.

*Chemical cleaning service for all industry*

DOWELL

DIVISION OF THE DOW CHEMICAL COMPANY

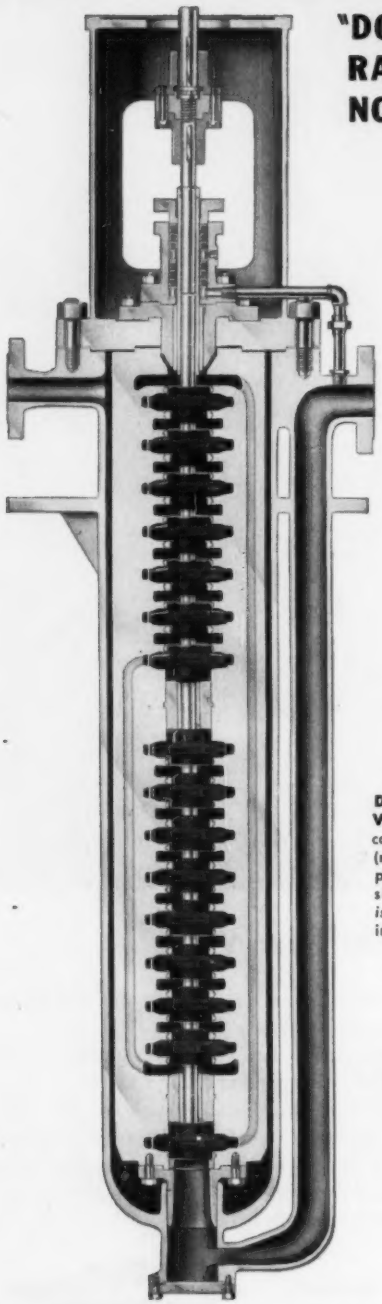


For more data on advertised products, use Readers' Service Cards, last page.

# Bingham

## DOUBLE VOLUTE DOUBLE CASE "HI-PRESS" PUMP

# UNSURPASSED HOT OR



## "DOUBLE VOLUTE" DESIGN PROVIDES HYDRAULIC RADIAL BALANCE OF ROTATING ELEMENT... NO "SIDE PUSH"...ELIMINATES WEAR AND SEIZURE

The "Double Volute" construction of Bingham Multistage "Hi-Press" Pumps insures perfect radial balance of the rotating element, under all operating conditions . . . completely eliminating wear between rotating and stationary parts. "Double Volute" construction permits maximum use, without exceeding normal clearances, of non-corrosive metallurgy – particularly austenitic steels – normally considered dangerous on account of their galling and seizing characteristics.

This feature also eliminates shaft deflection, permitting **mechanical seals** to establish and maintain a uniform track between contacting faces. This prevents leakage and seal face wear, resulting in **long life for all mechanical seals.**

"Double Volute" design also permits the pumpage to be discharged from the inner into the outer case through *two nozzles* located 180° apart. For hot service, this feature provides adequate circulation of pumpage between the two cases, insuring a uniform temperature rise in all parts – thereby eliminating distortion due to temperature changes.

Location of suction and discharge at top of pump case is particularly suitable for low NPSH conditions.

Bingham "Hi-Press" Pumps have established an exceptional record of long life and trouble-free service wherever they have been installed.

*Write your nearest Bingham office for full information.*

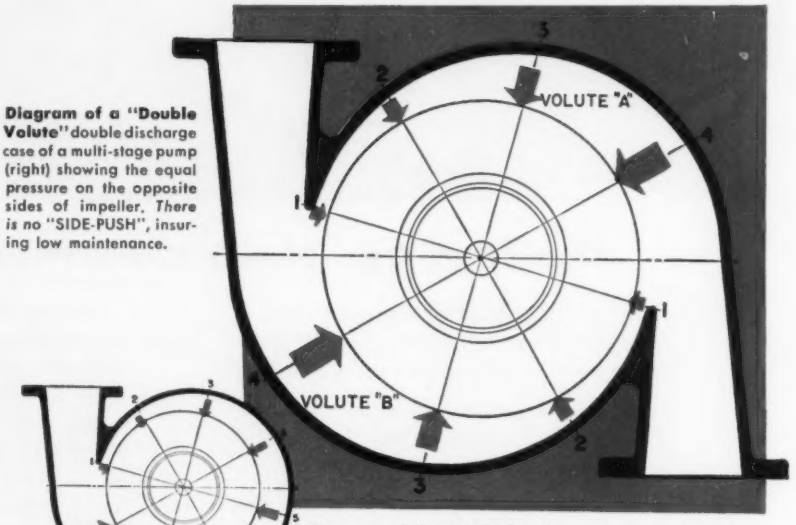


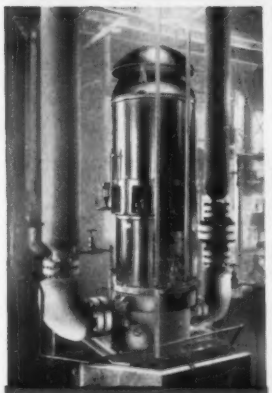

**Diagram of a "Double Volute"** double discharge case of a multi-stage pump (right) showing the equal pressure on the opposite sides of impeller. *There is no* "SIDE-PUSH", insuring low maintenance.

**Diagram of "Single Volute"** pump case (left) showing unequal pressures at opposite points around the periphery of the impeller. These unequal pressures cause "SIDE-PUSH" on the rotating elements, causing wear of rotating parts and, frequently, high maintenance.

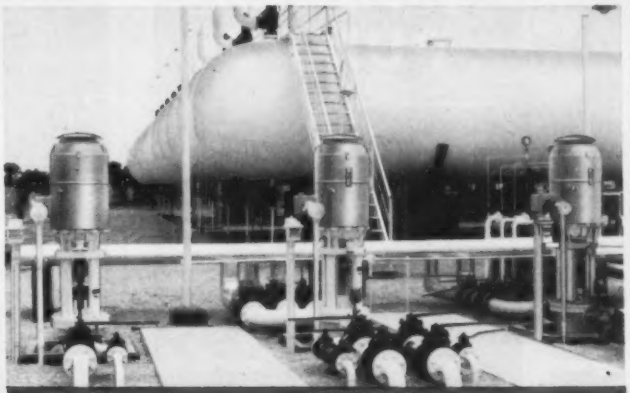


For more data on advertised products, use Readers' Service Cards, last page.

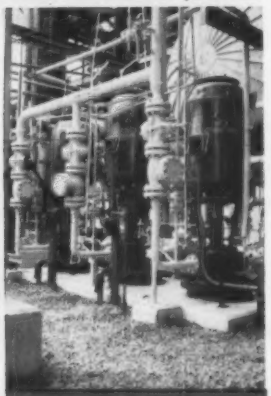
# FOR EXTREMELY HIGH PRESSURES
# COLD SERVICES



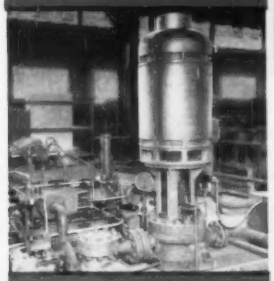
One of a group of Bingham Type HPD Pumps handling 750°F. crude in a large Eastern refinery.



Several Bingham Type HPD Pumps for loading butane under low NPSH conditions at a large Mid-Continent refinery.



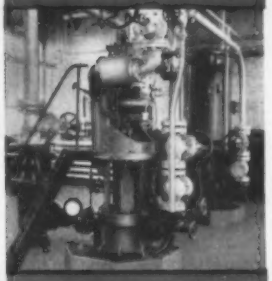
Bingham Type HPD Pumps in polymerization unit charge service at Sun Oil Co., Marcus Hook, Pa.



Bingham "Hi-Press" Pumps for testing pipe to 2500 psi, National Tube Company, Lorain, Ohio.

A group of Bingham "Hi-Press" Loading Pumps at a large cycling plant, Linn, Texas.

Battery of Bingham "Hi-Press" Pumps handling ammoniacal copper solution at 2500 psi, Lion Oil Co., Eldorado, Ark.



One of several Bingham "Hi-Press" Pumps handling 750°F. oil in a large Canadian refinery.

## PARTIAL LIST OF REFINERIES AND PETROCHEMICAL PLANTS USING BINGHAM "HI-PRESS" PUMPS

Ashland Oil & Refining Co.
British American Oil Co., Ltd.
Canadian Petrofina, Ltd.
Commercial Solvents
Continental Oil Company
Dow Chemical Company
E. I. duPont de Nemours & Co.
Escambia Bay Chemical Co.
Esso-Standard Oil Company
Gulf Oil Corporation
Imperial Oil, Limited
Jefferson Chemical Company
Lion Chemical Company
Magnolia Petroleum Company
McColl-Frontenac Oil Co., Ltd.
Monsanto Chemical Company
Ohio Oil Company
Petroleum Chemicals, Inc.
Phillips Petroleum Company
Polymer Corporation, Ltd.
Shell Oil Co. of Canada, Ltd.
Westinghouse Electric Company
Shell Oil Company
Socony-Mobil Oil Company
Standard Oil Co. of Indiana
Societe Industrielle, Belge
Spencer Chemical Company
Sun Oil Company
Tennessee Gas & Transmission Co.
The Texas Company
Union Carbide Chemicals Co.

Bingham SINCE 1921

DOUBLE VOLUTE PUMPS RADIAL BALANCE

**BINGHAM PUMP COMPANY**
*General Offices:* 2800 N.W. Front Avenue, Portland 10, Oregon
*Factories:* Portland, Ore. • Vancouver, B. C., Canada

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PHILADELPHIA, PA.
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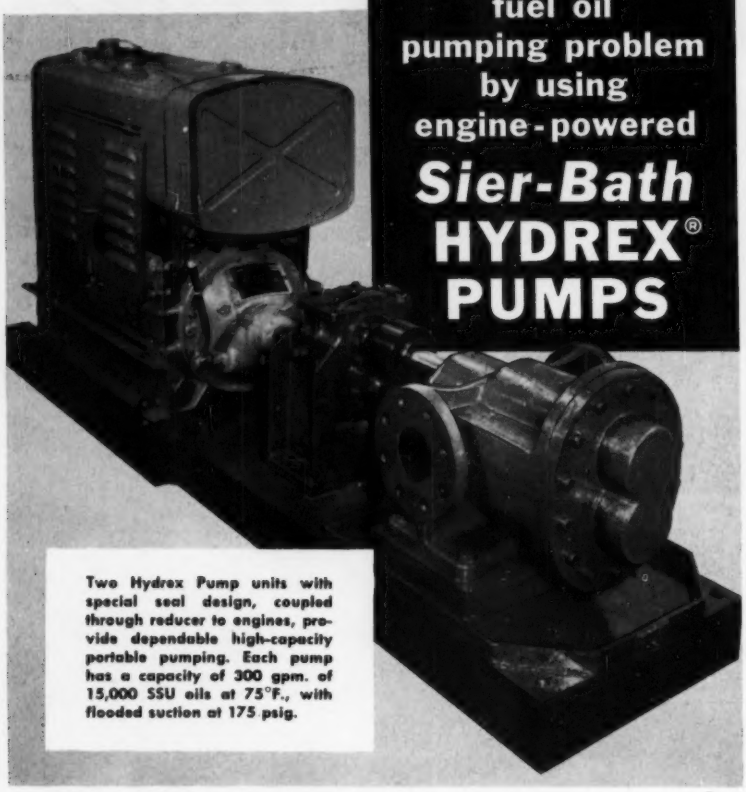
SAN FRANCISCO, CALIF.
SEATTLE, WASH.
ST. LOUIS, MO.
ST. PAUL, MINN.
TULSA, OKLA.
TORONTO, ONT., CAN.
VANCOUVER, B. C., CAN.


For more data on advertised products, use Readers' Service Cards, last page.

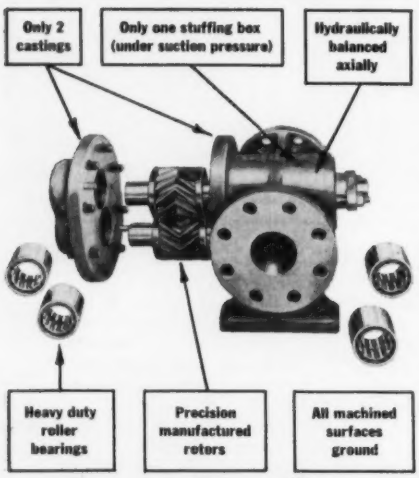
## In remote location --

## TEXACO solves fuel oil pumping problem by using engine-powered Sier-Bath HYDREX® PUMPS



Two Hydrex Pump units with special seal design, coupled through reducer to engines, provide dependable high-capacity portable pumping. Each pump has a capacity of 300 gpm. of 15,000 SSU oils at 75°F., with flooded suction at 175 psig.

### Sier-Bath HYDREX PUMP


Only 2 castings
Only one stuffing box (under suction pressure)
Hydraulically balanced axially
Heavy duty roller bearings
Precision manufactured rotors
All machined surfaces ground

The simplest heavy duty gear pump made! Use it in place of pumps costing much more... for handling chemicals, fuel oils, lube oils, hydraulic liquids, etc.

The "Hydrex" needs no costly speed reducer—can be direct-connected up to 1800 RPM. Extreme simplicity allows heavier construction, easier installation and maintenance, less downtime, longer life.

Models available to pump liquids from 32 SSU to 500,000 SSU, at 1 to 350 GPM, up to 500 PSI. See "Yellow Pages" for your local Sier-Bath Pump Representative or write to *Sier-Bath Gear & Pump Co., Inc., 9261 Hudson Blvd., North Bergen, N. J.*

## Sier-Bath ROTARY PUMPS

Screw Pumps | Gearex® Pumps | Hydrex® Pumps

Founded 1905 | Mfrs. of Precision Gears, Rotary Pumps, Flexible Gear Couplings | Member A.G.M.A.


## Men in the Industry . . .

main senior officer on the West Coast.

Elected to replace the two retired directors were **Donald K. Ballman,** director of sales, and **C. B. Branch,** manager, Plastics department. Replacing Curtis as Western division general manager will be **Leland A. Doan,** assistant general manager of the division since 1955.

Lutz

McBride

**Dr.'s Harold D. McBride** and **Eugene F. Lutz,** research chemists, have joined Ohio Oil Co.'s Research center near Denver. Dr. McBride received B.A., M.S. and Ph.D. degrees in chemistry from Ohio State University. Previous experience includes a research assistantship for the Kettering Foundation and teaching assistantships at Ohio State. He is a member of ACS. Dr. Lutz has a B.S. degree in chemistry from Regis College and M.A. and Ph.D. degrees in chemistry from Kansas State University. His experience includes teaching and research assistantships at Kansas State University. He is a member of ACS.

**Walter Squires, Jr.,** has been appointed an engineering associate by Esso Research and Engineering Co. A chemical engineer in the Design Engineering division, he started his career in 1937 at the affiliated Esso Research laboratories, Baton Rouge. He has been with the Linden laboratories since 1944. Squires has B.S. and M.S. degrees in chemical engineering from Massachusetts Institute of Technology.

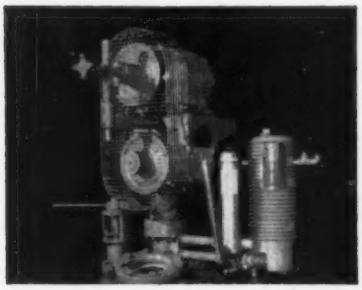
**Harold G. Mangelsdorf,** deputy coordinator of all refining activities of Standard Oil Co. (N. J.), has been elected to the board of directors of Esso Export Corp., an international sales affiliate. A graduate of Kansas State College and M.I.T. with a M.S. degree in fuel and gas engineering, he began with Jersey Standard in 1934 as an engineer at the Baton Rouge refinery of Esso Standard Oil Company.

Mangelsdorf

In 1958, Mangelsdorf became deputy coordinator of Jersey Standard's Refining Coordination department, a position he will keep.

**Thomas G. Gillespie, Jr.,** has been appointed a vice president of Scientific Design Co., Inc., in charge of legal and contract matters, and other development

# PFAUDLER
## CORROSIONEERING NEWS



## Neat compact W Drive packs a lot of power at low cost

Here's a compact, inexpensive drive that delivers up to 10 horsepower.

It's pedestal mounted so you'll find it readily adaptable to any tank, even including open vessels. It normally has a Glasteel impeller, so it's ideal for work with all corrosives. Alloy impellers and turbines also available.

**Carries heavier loads.** Both gear and pinion are throated, a design which gives maximum contact area to teeth —much more than with other worm drives. This translates into heavier load capacity.

**Requires little attention.** Maintenance on the W Drive consists almost entirely of periodic lubrication and an occasional check of alignment.

**SPEED RANGE WITH VARIABLE SPEED SHEAVES**

| Drive Ratio | 2.5W | | 3W | |
|---|---|---|---|---|
| | HP at Max. Speed | Agit. RPM Range | HP at Max. Speed | Agit. RPM Range |
| 5:1 | 2 | 600 to 128 | 3 | 600 to 128 |
| 10:1 | 2 | 300 to 64 | 3 | 300 to 64 |
| 20:1 | 2 | 150 to 33 | 3 | 150 to 33 |
| 30:1 | 1.5 | 100 to 22 | 2 | 100 to 22 |

Note: There are 4W and 5W drives which deliver 7.5 and 10 HP respectively in comparable speed ranges.

**Many modifications.** Use stuffing box or mechanical seal. Fixed speed or variable speed sheaves are standard. You can specify hydraulic, explosion-proof design. Or, double reduction gearing and flange-mounted motor.

For more details on the W Drive, send for Bulletin 965.

## More thermal shock data on new GLASTEEL 59

#53 Glass  Glasteel 59

As another example of the increased thermal shock resistance of our new Glasteel 59, we ran this laboratory test:

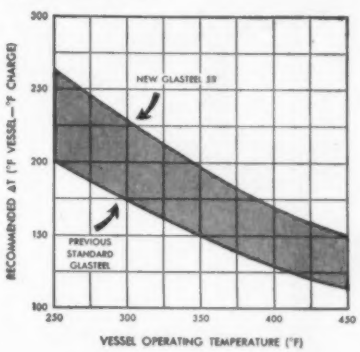
We glassed the outer convex surface of two 2-inch steel pipes, one with Glasteel 59 and one with our best previous material, #53 Glass.

Then we heated both to 525°F. and quenched them quickly in a 70°F. water bath. You can see what happened to #53 Glass (above, left). Glasteel 59 didn't show a sign of damage . . . in spite of a 455°F. instantaneous temperature change.

In other tests we heated the Glasteel 59 to 600°F.—a 530°F. △T—and even to 625°F.—a startling 555°F. △T. Still no sign of cracking or crazing or other damage on the Glasteel 59 test piece.

Naturally we do not recommend or suggest such severe treatment with your process equipment. Our point is this—with Glasteel 59, and only this glassed steel, can you have so high a degree of thermal shock protection. A full 30% increase over our previous best grade, as shown in chart below.

Thermal shock resistance is not the only property of Glasteel 59 that shows improvement. It gives you 20% better abrasion resistance and extended service life, too. If you'd like to know more about our complete line of Glasteel equipment, send for Bulletin 968.




75 YEARS CREATING FOR TOMORROW

**THE PFAUDLER CO.**
***a division of* PFAUDLER PERMUTIT INC.**
**Dept. PR-19, Rochester 3, New York**

Please send me: ☐ Bulletin 965, Pfaudler Type "W" Drive; ☐ Bulletin 968, Buyer's Guide to Pfaudler Equipment.

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COMPANY.....

ADDRESS.....

CITY..... ZONE..... STATE.....

*See Chemical Engineering Catalog pp. 1515-1526, for complete Pfaudler line.*



For more data on advertised products, use Readers' Service Cards, last page.

## Men in the Industry...

activities. He has a LL.B. degree from the University of Indiana, a B.S. degree in chemical engineering and a M.S. degree in chemistry from the University of Notre Dame. He was formerly with Patent departments of Koppers Co. and Sharp & Dohme, and joined SD in 1955.

**Dr. Alan M. Dobry** has been named a senior project chemist, Whiting Research laboratories, Standard Oil Co. (Ind.) He has carried out research in lubrication, the chemistry of surfaces, and radiation chemistry. He has a Ph.D. degree in chemistry from the University of Chicago.

**Dr. Robert D. Huntoon** has been named deputy director, National Bureau of Standards. He will serve as alternate to the director in external matters, and will exercise day-to-day direction and review of Bureau programs. He will continue as associate director for physics.

**W. Kenneth Davis,** vice president of the Bechtel Corp., San Francisco, and former director of reactor development for the U. S. Atomic Energy Commission, has won the AIChE's Professional Progress Award in chemical engineering. It was presented at the organization's Cincinnati meeting December 8. Davis has been an assistant director of the M.I.T. school of chemical engineering practice and a senior research engineer for the California Research Corp.

**William J. McGhee,** industrial microbiologist and biochemical engineer, has resigned his position as department head, fermentation development, Bristol Laboratories to join **Raphael Katzen,** D.Ch.E., and Raphael Katzen Associates International, Inc., Cincinnati. He earned a B.S. degree in chemistry from St. Louis University, then entered the Chemical Warfare Service at Pine Bluff Arsenal, Ark., and Fort Detrick, Md. He then obtained research, development, production and control experience at Merck & Co., Vulcan Engineering division, Eli Lilly & Co., and Bristol laboratories, and operating experience at Central LaFayette in Puerto Rico.

McGhee

**George P. Olsen** has joined Whiting Research laboratories, Standard Oil Co. (Ind.), where he will conduct pilot-plant studies of petrochemical processes. He has a M.S. degree in chemical engineering from the University of Delaware, and a B.S. degree from Illinois Institute of Technology.

**Eugene J. Houdry** has earned the Society of the Chemical Industry Medal which was presented at the Annual Perkin Medal Dinner, January 9.

He was honored for contributions to catalytic cracking. Houdry founded Houdry Process Corp. and Oxy-Catalyst, Inc. For a complete insight into this famous oil personality, read the "Refining Hall of Fame" section in this month's PETROLEUM REFINER.

**Forrest S. Elleman** has been appointed manager of The Pure Oil Co.'s General Engineering department. He attended Birmingham University in England and Harvard University, and joined Pure in 1947 as an electrical engineer. Since then he has served in various engineering executive capacities. He was named assistant manager, Engineering department in April, 1958.

**Dr. Leonard G. Tompkins** has been named technical manager for the Petrochemicals department, Organic Chemicals division, American Cyanamid Co. A graduate of Stetson University, and Purdue University, he taught at both the University of Idaho and Stetson for six years before joining Cyanamid's Research laboratories, Stamford, Conn., in 1953. Since 1954 he has been with the Market Development department in New York.

**Dr. Michael J. Rzasa** has been named manager of the Research laboratories, Cities Service Research and Development Co. Previously manager of exploration and production research at Tulsa, he has been manager of the development laboratory at Cranbury, N. J., since January, 1957. He will supervise all Cities Service Research laboratories from New York headquarters.

**Samuel G. Baker,** general manager of Organic Chemicals department, E. I. du Pont de Nemours & Co., has been elected president of the Synthetic Organic Chemical Manufacturers Association. He joined du Pont on the production line in 1923.

skid-mounted

**...with proportional sampler**

**Unit automatically shuts down after allowable has been flowed, with volume corrected to 60°F and registered on counter and/or ticket.**

**MECO sampler stores sample at line pressure.**

**Air and non-condensible gases are automatically separated from liquid and vented. Metering of gases is prevented.**

**Unit includes line-size strainer • SMITH line-size deaerator • float-operated pilot and safety shut-down valve • MECO proportional sampler • A. O. Smith positive displacement liquid meter • SMITH set stop valve.**

MECO
MAINTENANCE
Mechanical CORPORATION
SUBSIDIARY OF
MAINTENANCE ENGINEERING CORPORATION
P. O. BOX 2037 — 3711 CLINTON DRIVE
PHONE CA 2-2351 — HOUSTON 20, TEXAS




For more data on advertised products, use Readers' Service Cards, last page.

Chapman Cast Iron Valve for oil, water or gas service

*Since 1875*

# *Chapman Valves for the Petroleum Industry*

The Chapman Valve Manufacturing Company, since its organization in 1875, has kept step with developments in the Petroleum Industry; meeting promptly and efficiently the demands for valves to withstand increased pressure and temperature specifications. The Chapman line today covers a complete range of bronze, iron, cast and forged steel valves, and valves of special design for super-critical pressures and temperatures, as well as for unusual service conditions.

Keeping pace with the Petroleum Industry — keeping pace with all industries — has kept Chapman progressive and aggressive. All Chapman design and manufacturing practice is geared to meet exacting demands with valves that give top performance with lowest maintenance cost.

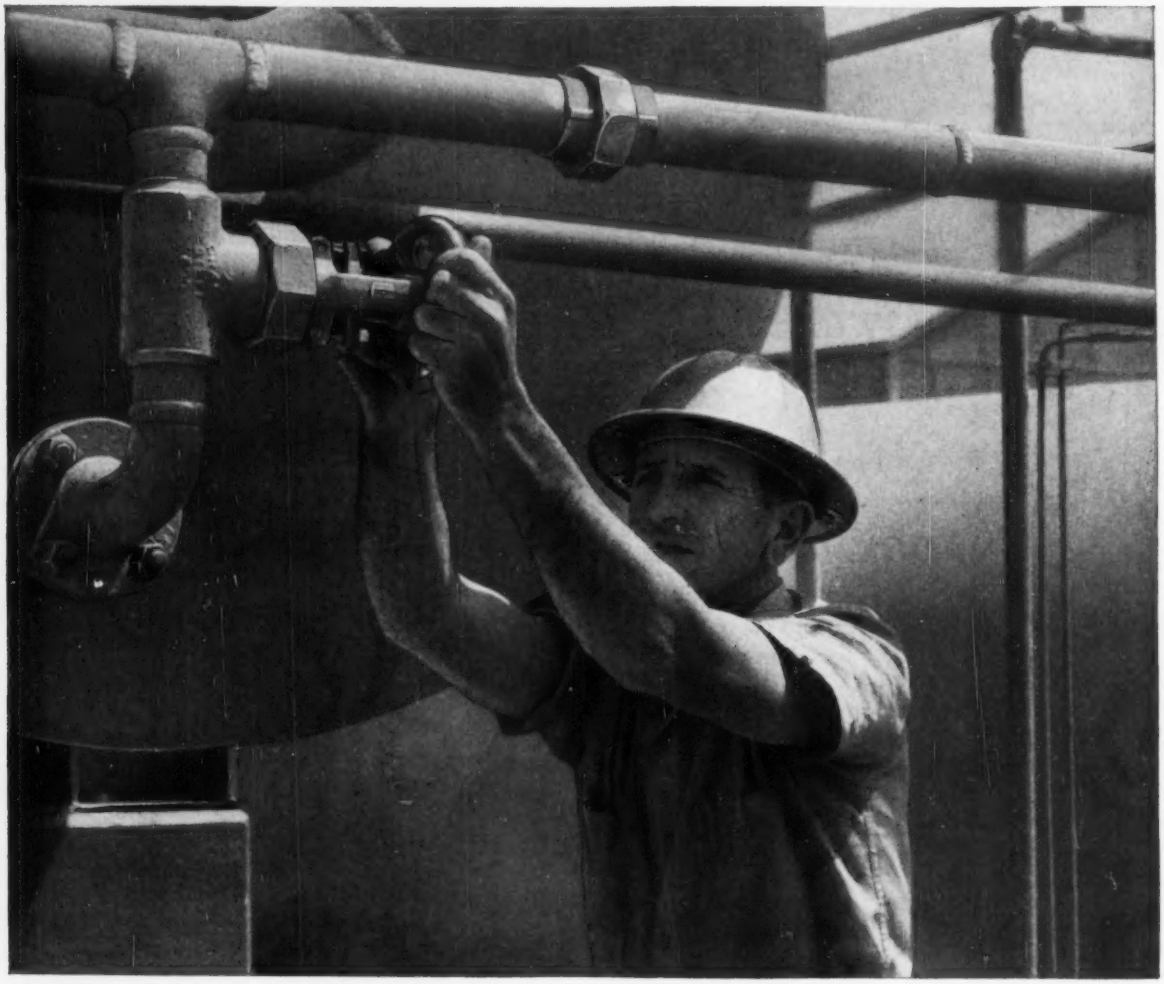
A Chapman U-bend valve with Coniflow Control designed and built by Chapman for catalytic cracking service.

*The* **CHAPMAN**
*Valve Manufacturing Co.*
INDIAN ORCHARD, MASSACHUSETTS



For more data on advertised products, use Readers' Service Cards, last page.

## How gasoline plant solves a serious valve problem



# Crane Valve Puts Fast Stop on Gasoline Leakage

Shortly after installation, the cock in a raw gasoline line at this large Southwestern gasoline plant began to stick and leak. Corrective maintenance failed to end the trouble.

So, for positive shutoff, the cock was replaced. But, this time, with a Crane No. 3602X 2-inch, 600-pound steel wedge gate valve. Now in operation more than nine months on the 100 psi gasoline line, it never sticks or leaks, and has needed no maintenance, not even frequent periodic lubrication.

Crane No. 3602X steel wedge gate valves are favorites in the oil and gas industries for installations on lines handling oil and oil vapors. They have Exelloy seats, disc and stem giving them extra-long-wearing surfaces to keep maintenance costs down. Compact yet rugged, these valves are well suited for many refinery and field applications.

**If you have valve problems,** you can depend on your Crane Representative for accurate, practical advice. Don't hesitate to ask for his help next time he calls. Or, write to address below for recommendations.

**Ask for Crane folder AD-1881,** which covers the Crane line of 600-pound small steel gate valves—with union bonnet or bolted bonnet.

# CRANE® VALVES & FITTINGS

**PIPE • PLUMBING • HEATING • AIR CONDITIONING**

*Since 1855—Crane Co., General Offices: Chicago 5, Ill.—Branches and Wholesalers Serving All Areas*

## Men in the Industry . . .

but left the company six months later to complete his education. Upon graduation from the University of Washington, he returned in 1925 as a chemist at the Eastern laboratory and the Repauno works, Gibbstown, N. J. Since then he has been special assistant at the Wilmington office, assistant manager of sales in the New York office, director of sales for the High Explosives Manufacturing division, general manager of the Electrochemicals department, and general manager of the Photo Products department. In 1956 he was made general manager of the Organic Chemicals department.

**A. F. Lorton, Jr.,** has been named to head Gulf Oil Corp.'s public relations activity for the south and west, with headquarters at Houston. He was director of public relations for Pacific Northwest Pipeline Corp., Salt Lake City, until recently. Lorton joined the natural gas transmission line in Houston at the beginning of construction and later moved to Utah when Pacific Northwest began operations.

Lorton

Since returning to Houston he has been with James A. Clark, oil and gas writer, in consulting work. He graduated from Simpson College, Indianola, Iowa.

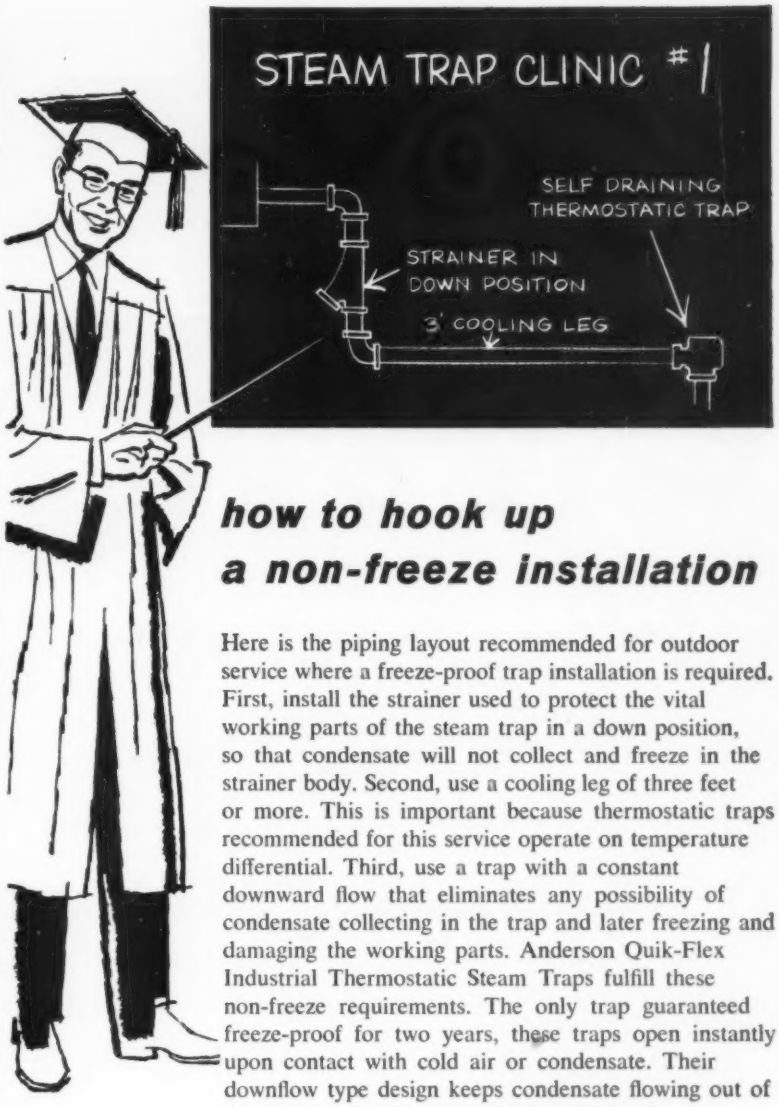
**O. L. Clevenger** has been promoted to senior supervising engineer in the Technical division at Humble Oil & Refining Co.'s Baytown, Texas, refinery. He supervises a group of engineers engaged in the mechanical design of refinery piping and equipment. Clevenger received a B.S. degree in civil engineering at The University of Texas.

**Dr. Merrell R. Fenske,** director of the Petroleum Refining laboratory at Pennsylvania State University, was presented a Certificate of Appreciation on the 30th Anniversary of the research relationship with the Pennsylvania Grade Crude Oil Association. He started the work of the laboratory at Penn State 30 years ago.

Dr. Fenske is known for his work on automotive fuels and lubricating oils, military aircraft lubricating oils, naval hydraulic fluids, etc.

**Paul E. Schmidt** has been named a group leader in chemicals research, Whiting Research laboratories, Standard Oil Co. (Ind.) He has conducted research on plastics derived from petroleum products, and will head a group that will evaluate and seek new uses for them. Schmidt has a B.S. degree in chemical engineering from Drexel Institute of Technology, is a member of ACS and the Society of Plastics Engineers.

**Leonard Raymond,** chief automotive engineer in charge of research, Socony Mobil Oil Co., New York, has been elected president of the Society of Automotive Engineers. His job at Socony Mobil is to relate today's research to tomorrow's engineering requirements. Raymond has been in automotive research ever since earning his M.S. degree at


**how to hook up a non-freeze installation**

Here is the piping layout recommended for outdoor service where a freeze-proof trap installation is required. First, install the strainer used to protect the vital working parts of the steam trap in a down position, so that condensate will not collect and freeze in the strainer body. Second, use a cooling leg of three feet or more. This is important because thermostatic traps recommended for this service operate on temperature differential. Third, use a trap with a constant downward flow that eliminates any possibility of condensate collecting in the trap and later freezing and damaging the working parts. Anderson Quik-Flex Industrial Thermostatic Steam Traps fulfill these non-freeze requirements. The only trap guaranteed freeze-proof for two years, these traps open instantly upon contact with cold air or condensate. Their downflow type design keeps condensate flowing out of the trap so that it cannot freeze as it cools. Mail coupon for complete details.

ANDERSON QUIK-FLEX STEAM TRAPS

THE V. D. ANDERSON COMPANY
division of International Basic Economy Corporation
1953 West 96th Street • Cleveland 2, Ohio

Please send additional information on Anderson freeze-proof Quik-Flex Thermostatic Steam Traps.

*Name* _____ *Title* _____

*Company* _____

*Address* _____

*City* _____ *Zone* ____ *State* _____

*Guaranteed Not to Freeze*




For more data on advertised products, use Readers' Service Cards, last page.

## Men in the Industry . . .

Columbia University and has been with Socony Mobil since 1945. He has been prominent in the Society's technical activities for many years and last year was chairman of its Publication committee.

**H. M. Thorne** has been named research director of the newly formed Laramie Research center at the University of Wyoming. It was formerly a Bureau of Mines station. Thorne received a B.S. degree in chemical engineering at the University of Oklahoma in 1924 and entered the Bureau of Mines in the same year, serving in turn at Bartlesville, Boulder, Colo., and since 1930 at Laramie.

**Dr. Robert L. Pigford,** University of Delaware, has won AIChE's William H. Walker Award. A department head and professor of chemical engineering at Delaware, he won the award for "distinguished contributions to chemical engineering literature." Dr. Pigford has a B.S. degree in chemical engineering from Mississippi State College, and M.S. and Ph.D. degrees in chemical engineering from the University of Illinois. He was a chemical engineer with E. I. Du Pont de Nemours & Co. before assuming his professorship at the University of Delaware in 1947.

He is a co-author of two books on chemical engineering and has authored articles on applied mathematics and unit operations in numerous publications. He is an industrial consultant on unit operations and thermodynamic problems.

**G. T. Gwin** has been promoted to research specialist in Humble Oil & Refining Co.'s Research and Development division, Baytown, Texas. He is specializing in problems associated with the production of aviation fuels, turbo fuels, and special fuels for supersonic planes and missiles. Gwin holds a B.A. degree in chemistry from Rice Institute.

**John H. Ashenfelter** has been named assistant to the director of industrial relations at Sun Oil Co. He joined Sun at the Marcus Hook Refinery in 1933 and was named assistant personnel manager there in 1940. Four years later he was named personnel manager, Philadelphia. He attended Drexel Institute of Technology and the University of Pennsylvania, majoring in personnel administration.

**E. Duer Reeves** has been elected an assistant vice president of Esso Standard Oil Co., and a director and vice chairman of the Executive Committee of the Esso board of directors. He has been executive vice president of Esso Research and Engineering Co. since 1949. Reeves joined the company in 1930, following graduation from Williams College and graduate work at Princeton University.

Reeves

In 1937, he was named director of the newly-formed Process Development unit. He was named director of the Research division in 1945, and two years later became a director and vice president of the research company. Reeves was active for some years in the Industrial Research Institute and served a year as its president.

He is a member of the Society of the Chemical Industry and ACS.

## – Deaths –

**George W. H. Reid,** editor of PETROLEUM REFINER from 1934-39, died December 24 in Houston at age 63. Before joining the REFINER staff in 1926 he was a chief chemist and refinery superintendent in several important Mid-Continent refineries, and was a chemistry graduate of the University of Arkansas. He worked for the REFINER in California and Oklahoma before becoming editor. In 1939 he became director of the Gulf Coast Refiners Association. He held this position until 1947, when he joined Platt Publishing Co., where he remained when it was absorbed by McGraw-Hill Publishing Co. Reid eventually became an assistant publisher in the McGraw-Hill Houston office, a position he held until his death. Since 1955, he had worked in sales research for "Petroleum Week" magazine, a McGraw-Hill publication. The funeral was held December 26 in Houston. Reid's survivors include his widow, a son and daughter, two grandchildren and a brother.

Reid

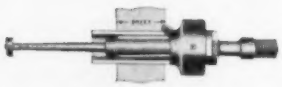

WIEDEKE

THE QUALITY NAME IN TUBE EXPANDERS . . . SINCE 1892

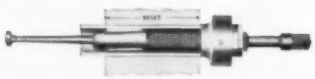
**Tube Expanders for Condensers**

No. 255—for average tube sheets

No. 270—for thick or multiple tube sheets



No. 255—Adjustable for sheets up to 2¼" thick



No. 270—Adjustable for sheets up to 7½"

#36

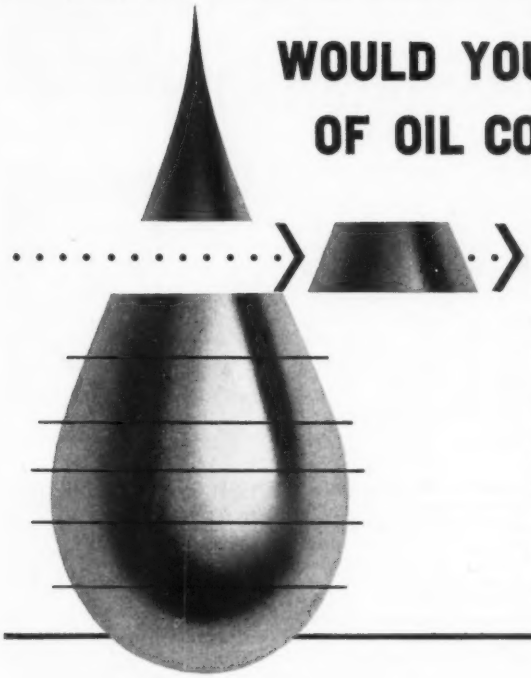
IDEAL Ball Bearing Tube Expanders are made of special analysis alloy tool steels, carefully heat-treated to withstand the severest operating strains. They are adaptable for use with any torque controlled tube rolling units—air, electric or mechanical. *Confidence* is your assurance that your job will be done *RIGHT* . . . when you use WIEDEKE Specialized Tube Expanders, Tube Cutters and Operating Accessories. There is a Wiedeke Distributor in every principal city. For further information write for *new* General Catalog 81.

**The Gustav WIEDEKE Company**

**Dayton 1, Ohio**

# ENGINEERING

**NEWS YOU CAN USE ABOUT ENGINE AND COMPRESSOR PERFORMANCE**



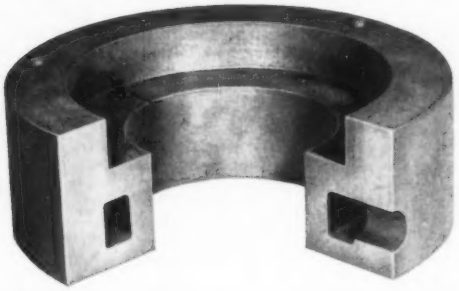
## WOULD YOU BELIEVE THAT ONE DROP OF OIL COULD BE THIS IMPORTANT?

Take a 12 cylinder, 2,000 HP, 330 RPM engine... let just **ONE-EIGHTH OF A DROP** of additional oil per stroke be used in each cylinder and here's what will happen: your oil consumption rate will increase from 8000 BHP hours per gallon to 2000!

And that's the big reason Cook rings save you money. Like other oil control rings, Cook rings meter oil and properly spread it, but Cook rings do this in addition: *they prevent excessive use of oil!*

Don't just get oil wiper rings . . . get Cook *engineered* conformable oil wiper rings, the most copied oil control rings in the world!

## KEEPS PACKING COOL ... AND IT'S LEAK-PROOF!



Cook's new leak-proof packing cup features circulating water completely *inside of the cup itself* . . . eliminates any possibility of leakage, corrosion or contamination of the material under compression. These are big advantages for all applications—and are naturally of even greater importance on non-lubricated service.

## WRITE FOR COOK'S NEW PISTON RING CATALOG

Sixteen-page catalog just off the press. Describes complete line of piston rings manufactured by C. Lee Cook Company, also the special rings of the Airtomics Division. For your free copy, write: C. Lee Cook Company, 950 South 8th Street, Louisville 3, Kentucky.

**C. LEE COOK COMPANY**

Division of Dover Corporation

*Rings and Packings Since 1888*

# What Suppliers Are Doing . . .

Bishop

**Clifford W. Bishop** has been appointed manager of Consolidated Electrodynamics Corp.'s Southwestern Regional Sales office, Dallas. During the past year, he has been sales manager of the Analytical and Control Instrument division. Previously, he was manager of the district sales office in Dallas for two years. Before joining CEC, Bishop was a research physicist with Continental Oil Co., and a junior physicist with Phillips Petroleum Co. A graduate of Oklahoma State University, he is a member of ACS and ISA.

Dulberg

**Irving Dulberg** has been named manager of research and quality control for J. H. France Refractories Co., Snow Shoe, Pa. A graduate of the School of Mines and Metallurgy of the University of Missouri with a B.S. degree in ceramic engineering, Dulberg joined J. H. France Refractories in 1953 as a ceramic engineer. Before joining the company, he was an instructor in mineral technology extension at Pennsylvania State University. He will be responsible for all research and quality control projects, and the company's research laboratories.

Gaudion

**Donald A. Gaudion** has been elected president of Pfaudler Permutit Co. A graduate of the University of Rochester and Harvard graduate school of business administration, he joined Pfaudler in 1948 as assistant to the president. Elected to the board of directors in 1951, he became vice president in charge of sales and advertising in 1952 and was named executive vice president in 1955. Prior to joining Pfaudler, Gaudion was with Eastman Kodak Co. seven years and with Kryptar Corp. for three years, gaining experience in market research, management report work and sales administration.

Tagge

**Edward P. Tagge** has been named general auditor of Beckman Instruments, Inc., and **Robert A. Lineberger**, controller of the company's Helipot and Scientific and Process Instruments divisions. Tagge, who was formerly controller for the two Fullerton, Calif., divisions, joined Beckman in 1952 as controller for the Scientific Instruments division and moved to a similar capacity at Helipot in 1957. Previously, he was with Firestone Tire and Rubber Co., Los Angeles, and Ernst & Ernst, Los Angeles, certified public accountants.

Bollay

**Eugene Bollay** has been named director of research in the Meteorology Instrumentation department, BJ Electronics, Borg-Warner Corp., Santa Ana, Calif. He was formerly president and technical director of Northam Electronics, Inc., recently acquired by BJ Electronics. Bollay will serve in specialized areas of instrumentation and applications that relate to weather and meteorology. Widely known in meteorology, geophysics, and weather research, he formerly headed the Guided Missiles section, Naval Ordnance Test Station, China Lake, Calif., and was project officer of a high altitude cosmic ray research program.

Mattimore

**J. D. Mattimore** has been named vice president for product engineering and research, Tube Turns division, Chemetron Corp. He has been director of Tube Turns' Product Engineering and Research department and will continue to supervise its work. Mattimore joined the firm as assistant director of research in 1942, following 12 years as development design and works engineer with Walworth Co. He graduated from Stevens Institute of Technology in 1922, and is a member of ASA, API, MSS and AWS.

Hastings

**Clark L. Hastings** has been elected president of Rochester Manufacturing Co. He was formerly vice president in charge of sales and advertising. Early this year he was named president of the company's subsidiary, Rochester Manufacturing Co. of Calif., Pasadena, Calif. He joined RMC in June, 1928 after graduation from Union College. He worked in plant operations and sales, and in 1938 was named vice president and sales manager. Hastings is past president of the Rochester, N. Y., Advertisers and a former member of the board, National Industrial Advertisers.

Howland

**William S. Howland** has been appointed eastern manager of heating sales for John Wood Co.'s Heater and Tank division, Conshohocken, Pa. His experience in oil and gas heating began in 1919 when he joined Petroleum Heat and Power Co., after completing a course in electrical engineering at Lowell Institute, Massachusetts Institute of Technology. In 1927 he went with a large oil burner company as service manager. After a number of years there, he joined Anchor Post Co. as a district manager, Fluid Heat division. When John Wood Co. acquired this division three years ago, Howland became special field representative.

Weir

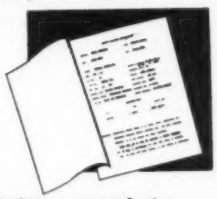
**James V. Weir** has been named to head the New York Girdler Catalyst office of Chemetron Corp.'s Chemical Products division. Weir's experience is in administration and research in cracking and specialty catalysis. Before joining Girdler, he was manager of administration and services for the Research division, Minerals and Chemicals Corp. of America, Menlo Park, N. J. He had previously been with Davison Chemical Co., Baltimore. Weir is a graduate of Georgetown University, and has a M.S. degree in physical chemistry from Catholic University, Washington, D. C.

Bumpus

**William W. Bumpus** has been named manager of Consolidated Electrodynamics Corp.'s new government liaison office in Washington, D. C., where he was formerly regional systems engineer and manager of the company's district sales office. A graduate of the U. S. Military Academy with a B.S. degree in engineering, he joined Consolidated in 1955 as a field engineer in the Atlanta district office. He became acting manager there four months later and manager of the Washington sales office the following year. Bumpus left CEC in 1957

# How Oakite ECP engineered cleaning program speeds turnarounds, cuts maintenance costs

Oakite ECP stands for Engineered Cleaning Programs. It is chemical cleaning tailored individually for specific refineries to give the shortest turnaround time consistent with good results. Each ECP takes into account a refinery's particular conditions, equipment, through-put. It itemizes the problems involved, and suggests methods and materials to solve those problems. In putting the chemistry of cleaning to work, it utilizes the experience of Oakite engineers, the latest research results and the skills of laboratory and field technicians.



### Specific Recommendations

The Oakite ECP makes specific cleaning recommendations, valve by valve, tower by tower. It includes estimates of material quantities needed and off-stream time expected for specific items of processing equipment and specific areas of general refinery maintenance.

### Process Equipment Cleaning

- Bubble cap, cascade and perforated tray type towers
- Raschig ring towers
- Heat exchangers
- Condensers
- Reboilers
- Preheaters

### General Refinery Maintenance

- Storage tank cleaning
- Tank car and truck cleaning
- Reclamation of valves, fittings, pipe
- Drum washing
- General Cleaning of Equipment and work areas for safety and appearance

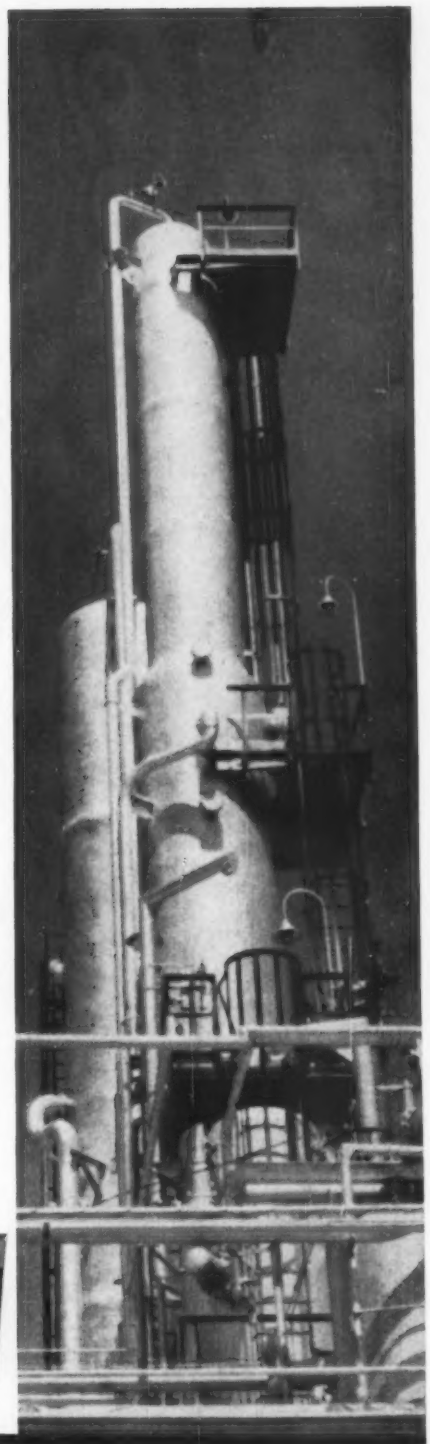
### Research Laboratory Service

The world's finest laboratory facilities engaged in cleaning research are offered to analyze stubborn soils, recommend suitable cleaners, and implement the Oakite petroleum engineers' knowledge in all phases of refinery cleaning.

### Detailed Engineering Assistance

A fully staffed engineering department develops standard mechanized cleaning units with a wide variety of refinery uses. Among these important developments are The "Hurriclean" Steam-Detergent Gun for removing caked-on soils from salvage parts too large for tank immersion. The Interior Tank Cleaning Unit to expedite change-over in cars and barges. The portable Hot-Spray Unit for general maintenance cleaning in and around pump houses.

**FREE BOOKLETS** *give details of Oakite Engineered Cleaning Programs. Write Oakite Products, Inc., 50B Rector Street, New York 6, N. Y. Better yet, ask your local Oakite man to develop an ECP for your refinery. There's no obligation, of course.*



OAKITE

50 1909-1959 SCIENCE years' leadership in industrial cleaning

Export Division Cable Address: Oakite

Technical Service Representatives in Principal Cities of U. S. and Canada

Oakite ECP

*your economy key*



For more data on advertised products, use Readers' Service Cards, last page.

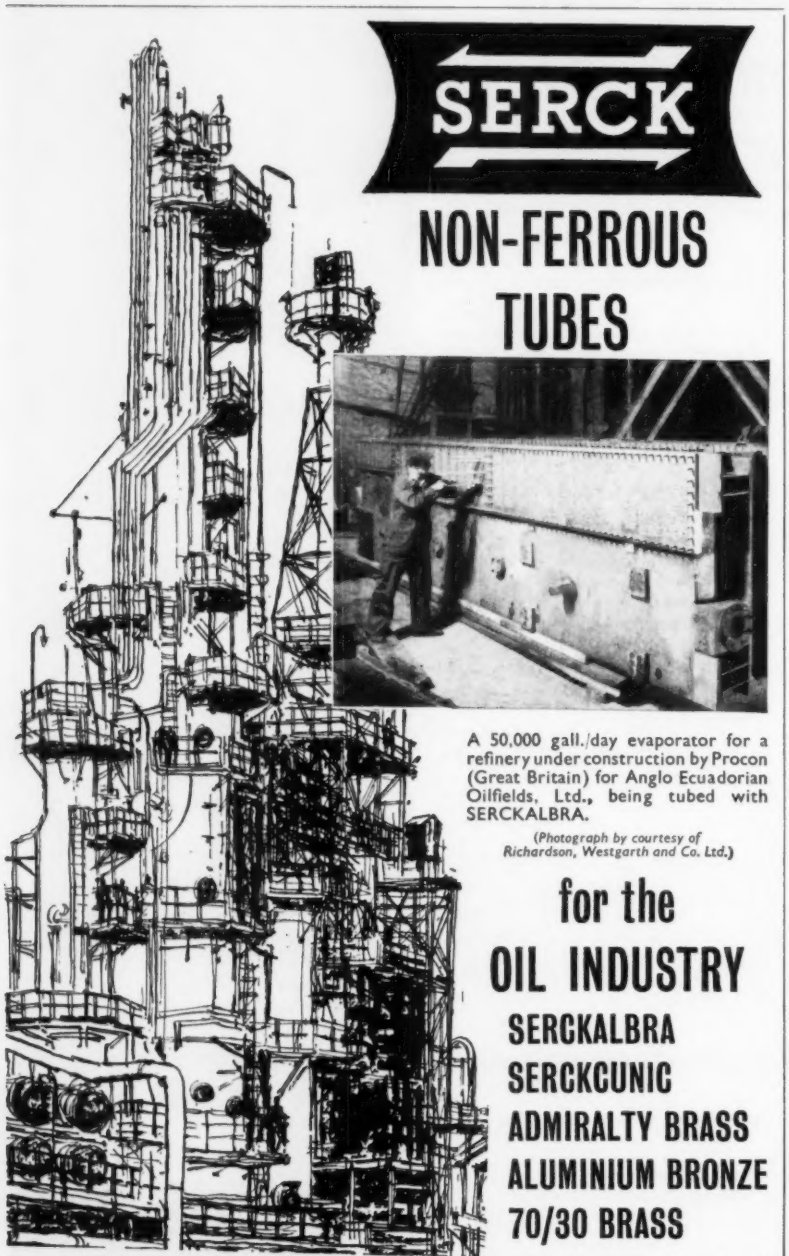
## Suppliers . . .

to become marketing director for Hycon Eastern, Inc. He rejoined the company in December, 1957, as regional systems engineer in the Southeast.

**TWIN DISC CLUTCH CO.'s John B. Jenkins** has retired after 32 years of service. He joined Twin Disc as a sales engineer in 1926 when the company was eight years old. In 1936 he went to Tulsa, to open the first Twin Disc factory branch. Later he opened other branches in Dallas and St. Louis. Since 1947 he has been in charge of the Detroit office.

**OLIVER TYRONE CORP.'s** Berry Hydraulics division has established a new southern district office at the factory in Corinth, Miss., with **H. S. Cain** as manager. He has been with the company four years, and was formerly in charge of the Houston district office.

**ALLIED CHEMICAL CORP.'s** Solvay Process division has appointed **John W. Priesing** West Coast sales represantive, responsible for developing sales in the Pacific Coast states. A graduate of Amherst College he has a M.B.A. degree from Harvard Business School. He joined Allied in 1956 as a financial analyst, and later transferred to Solvay's Detroit Sales branch. He is now at the Allied sales office, San Francisco.

SERCK

NON-FERROUS TUBES

A 50,000 gall./day evaporator for a refinery under construction by Procon (Great Britain) for Anglo Ecuadorian Oilfields, Ltd., being tubed with SERCKALBRA.

*(Photograph by courtesy of Richardson, Westgarth and Co. Ltd.)*

for the OIL INDUSTRY

SERCKALBRA
SERCKCUNIC
ADMIRALTY BRASS
ALUMINIUM BRONZE
70/30 BRASS

Serck Tubes Limited, Warwick Road, Birmingham 11, England

Barstow

Broun

**SOUTHWEST INDUSTRIES, INC.,** Houston, has opened a new office in Calgary, Alberta, Canada. The office's executives, all professional engineers, are **E. C. Broun, Jr.**, general sales manager; **Carl J. Maki**, elected president of the Canadian subsidiary, Southwest-Barber, Ltd., and head of the new Canadian office; **W. F. Barstow**, industrial sales manager, and **Charles E. Richards, Jr.**, sales engineer.

**U. S. STEEL CORP.'s** Oil Well Supply division has appointed **Ben Brooks** city representative at El Paso, Texas. He joined the division in 1948, and left it in 1955. He returned in 1956 as field representative at Hobbs, N. M., where he was before his present appointment.

**THE GRISCOM-RUSSELL CO.** has established a new Sales department for sea water distilling plants at Massillon, Ohio. **J. W. Connolly** will supervise the work of the new department. He has been in foreign sales of this equipment for Griscom-Russell for several years.

**LADISH CO.** has appointed **Herbert L. Pehrson** general sales manager of the company's Ladish Pacific division, Los Angeles. For the past 11 years he has been manager of West Coast sales.

**CLEAVER-BROOKS CO.** has acquired the 68-year-old Springfield Boiler Co., Springfield, Ill. The company reports that the transaction involves a $1 million investment.

**COOPER ALLOY CORP.** has appointed **Carl J. Tylka** director of technical service. He joined the company in 1956 as a nuclear project engineer. He was previously with the Knolls Atomic laboratories as a component engineer. Tylka has a B.S. degree in chemical engineering.

**SCHUTTE AND KOERTING CO.** has appointed **L. J. McKinley** district manager of the Buffalo, N. Y., office. With SK ten years as a design and sales engineer, he was last assigned to the New York office as sales engineer.

**GARDNER-DENVER CO.'s** sales organization has put 74 of its staff members through the firm's first Management School, Quincy, Ill. It offered instruction in problem solving, decision making, motivation and personnel supervision. The six-day school was designed for Gardner-Denver men who have been receiving increasing management responsibilities or who will be assuming them in the future.

**WALL COLMONOY CORP.** has appointed **E. D. Barnes** and **H. H. Barnett** application engineers in Houston and Birmingham respectively. Barnes studied metallurgical engineering at Oklahoma State University, and has been welder and welding consultant with several firms in the petroleum industry. He taught welding at



For more data on advertised products, use Readers' Service Cards, last page.

**...in fluid catalytic cracking**

# DUCLONES® recover catalyst in world's leading refineries

Control of catalyst dust in reactors and regenerators of fluid catalytic cracking units is essential from the standpoints of operating efficiency, economy and air pollution control.

Type SDC Duclones and Ducon Dip-Leg Trickle Valves offer the ultimate in catalyst recovery systems. They have earned the enthusiastic approval of the world's leading refineries because of their consistently high efficiency, low pressure loss and long service life under high temperature and erosive conditions. Type SDC Duclones are available in a wide range of materials, sizes, plate thicknesses and multiple groupings. They can also be supplied lined with a refractory material.

*Send today for Bulletins C-2058 and V-1458.*

*Photo courtesy Tidewater Oil Co.*

DUCON — DUST CONTROL SYSTEMS AND EQUIPMENT

**the name in DUst CONtrol**

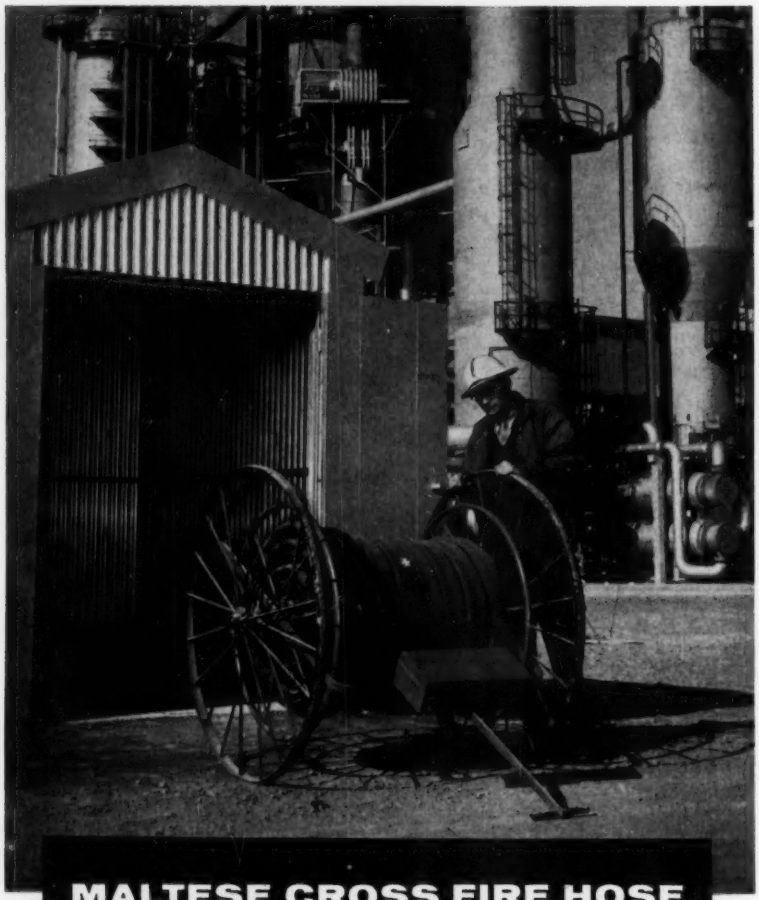
**THE Ducon COMPANY INC.**
**147 EAST SECOND STREET • MINEOLA, L. I., NEW YORK**

**Canadian Branch:**
**THE DUCON COMPANY of CANADA, Ltd.,**
**1131 Pettit St., BURLINGTON, ONTARIO**

**CYCLONES • CENTRIFUGAL WASH COLLECTORS • TUBULAR CLOTH FILTERS • DUST VALVES**



For more data on advertised products, use Readers' Service Cards, last page.



**MALTESE CROSS FIRE HOSE GIVES GREATER SAFETY, LASTS FIVE TIMES LONGER**

Because it lasts five times longer than ordinary fire hose, Maltese Cross proved the most economical choice for the Tidewater Oil Company refinery near Wilmington, Delaware. It averages fifteen to twenty years' life in refinery service. Other benefits for Tidewater are Maltese Cross' 10 to 35 times greater fire resistance, and easier, safer handling for firemen.

The hose is placed on reels located at strategic points and is also carried on the refinery's fire trucks. Its neoprene cover makes it resistant to petroleum, mildew, and rot; and it is so constructed that it will not swing, writhe, twist, elongate, or contract under pressure. To find out how H-R products and services can help you, consult your classified telephone directory for the nearest H-R representative, or contact Hewitt-Robins, Stamford, Connecticut.

**HR HEWITT-ROBINS**

CONVEYOR BELTING AND IDLERS . . . POWER TRANSMISSION DRIVES
INDUSTRIAL HOSE . . . VIBRATING CONVEYORS, SCREENS & SHAKEOUTS

## Suppliers . . .

Oklahoma State, and before joining Wall Colmonoy, was welding advisor on automatic and manual welding procedures for Hughes Tool Co., Houston.

Barnett has worked in gas and electric welding for nearly 20 years. He has dealt with both light and heavy equipment, and has taught welding at City School, Birmingham. He was previously with Tennessee Coal and Iron Co., Birmingham.

Kott

Coffman

**MILTON ROY CO.** is opening branch offices in Los Angeles and San Francisco. **Edward G. Kott** will be branch manager, San Francisco office. An electrical engineering graduate from Rose Polytechnic Institute, he was formerly engineering representative in northern California for an electrical equipment manufacturer. **Wilson R. Coffman** will supervise the Los Angeles office serving southern California. He holds a B.S. degree in mechanical engineering from the University of Kansas, and has several years' experience as sales engineer for a leading instrument manufacturer.

**CONSOLIDATED ELECTRODYNAMICS CORP.** has appointed **Paul N. Bertness** advertising manager. He will manage the advertising and direct-mail campaigns of Consolidated's product divisions and edit *CEC Recordings*, the company's external publication. Bertness joined CEC in 1955 as a technical writer, became editor of *CEC Recordings* in 1956, and divisional advertising manager a year ago. He is a graduate of Occidental College.

**ARTHUS S. LaPINE AND CO.** has appointed **Garland W. Smith** Virginia and North Carolina representative, with headquarters in Richmond.

Smith, formerly with Phillip Morris, Inc., has spent several years in the design of electromechanical equipment for research and development laboratories.

**BUCKEYE PIPE LINE CO.** and Chicago Bridge & Iron Co. have formed Buckeye Tank Terminals, Inc., to construct, own, and operate terminal tankage on the Buckeye Pipe Line system, or at other locations. It will arrange for use of those facilities by a specified individual customer.

**RAYBESTOS-MANHATTAN, INC.** has moved its San Francisco district warehouse and offices to 168 Beacon St., South San Francisco.

**PITTSBURGH PLATE GLASS CO.** has appointed **Dr. Howard L. Gerhart** director of research and development for the Paint and Brush division. Now research director, he will also supervise development and technical programs of the Paint and Brush division. He joined the company in 1937 as a chemist at the Milwaukee Research



For more data on advertised products, use Readers' Service Cards, last page.

# *A message to every engineer who wants to*
# keep fluid mixing costs down

Don't be fooled by *low purchase price* when you specify mechanical mixers for fluids.

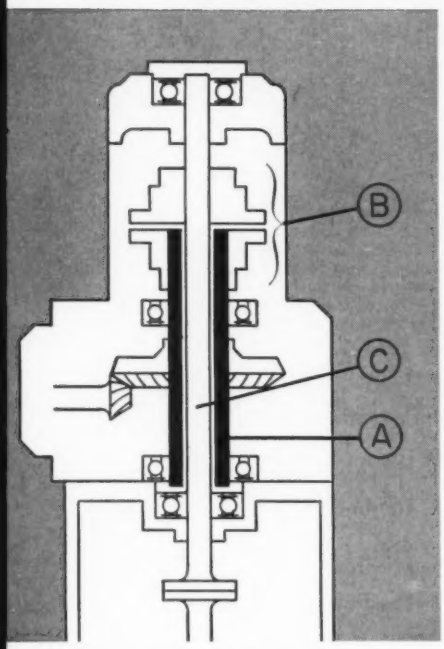
First cost is a very small fraction of your total mixing cost.

To find the *real* savings, look behind the price tag. Which mixer design will give you simplest, cheapest maintenance over the years? Most dependable month-in, month-out service? Greatest adaptability if mixing conditions change? Lowest spare-part requirements?

These are the areas where you can *really* save money on fluid mixing. And here are some of the reasons why you can do it more surely with LIGHTNIN Mixers than with any other mixer available.

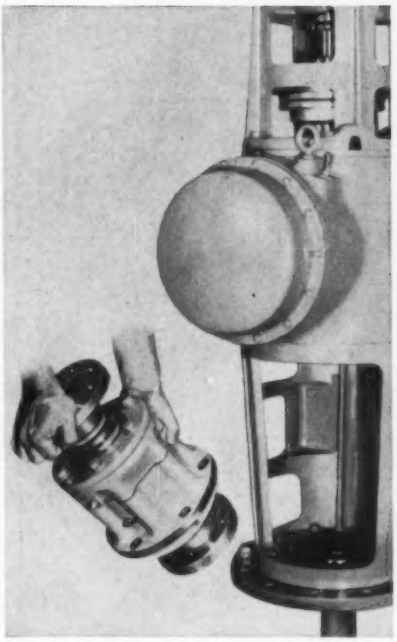
For lower-cost fluid mixing, see your LIGHTNIN representative soon. He's listed in Refinery Catalog. Or write us direct.

## Only *Lightnin* Mixers cut your mixing costs these 3 ways



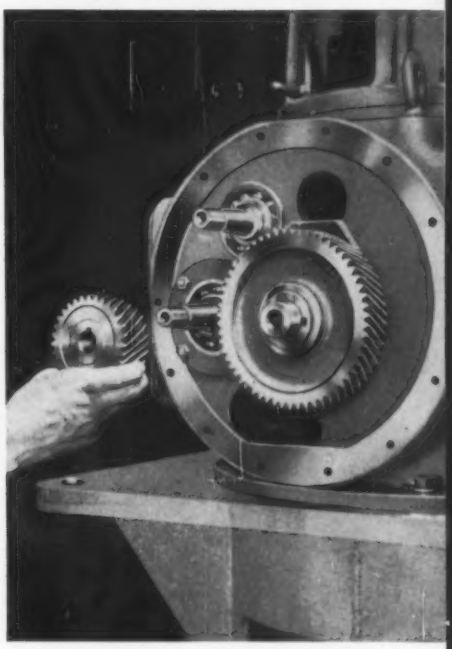

**1. PROTECTED GEARING.** Ever think what could happen to a mixer's gearing if something in the tank should accidentally damage the shaft? Shocks or flexures *don't reach the gears* in a Series "E" LIGHTNIN Mixer. Hollow quill* (A) isolates gearing from shaft. Flexible coupling (B) transmits power from gears to shaft—soaks up mixer shaft loads. Mixer shaft (C) is easily removed without risk of disturbing gear alignment.

*Patented



**2. EASIER, SAFER SEAL CHANGE.** Cartridge-type rotary mechanical seal† eliminates leakage under pressure or vacuum, runs for years without adjustment, and can be replaced in minutes without skilled manpower *and without disturbing gearing or shaft alignment.* Basis of this extra safety and convenience is the hollow quill of the reducer, which lets mixer shaft move up and down freely. You get this construction only with LIGHTNIN Mixers.

†Patent pending



**3. INTERCHANGEABLE SPEEDS.** Should your mixing requirements ever change (within the mixer's rated limits), you can quickly adapt your LIGHTNIN to meet the new needs. Change gears‡ provide as many as 16 standard AGMA output speeds from the same basic drive. You can change speeds without dismantling the mixer or removing it from the tank. This cost-cutting feature, like all the others shown on this page, is a LIGHTNIN "first."

‡Patented

**WHAT MIXING OPERATIONS ARE IMPORTANT TO YOU?**
You'll find a wealth of information on fluid mixing in these helpful bulletins describing LIGHTNIN Mixers:

- ☐ Top or bottom entering; turbine, paddle, and propeller types: 1 to 500 HP (B-102)
- ☐ Top entering; propeller types: ¼ to 3 HP (B-103)
- ☐ Portable: ⅛ to 3 HP (B-108)
- ☐ Confidential data sheet for figuring your mixer requirements (B-107)
- ☐ Laboratory and small-batch production types (B-112)
- ☐ Condensed catalog showing all types (B-109)
- ☐ Quick-change rotary mechanical seals for pressure and vacuum mixing (B-111)
- ☐ Side entering: 1 to 25 HP (B-104)

*Check, clip and mail with your name, title, company address to:*

**MIXING EQUIPMENT Co., Inc., 164-a Mt. Read Blvd., Rochester 3, N. Y.**

*In Canada: Greey Mixing Equipment, Ltd., 100 Miranda Ave., Toronto 19, Ont.*

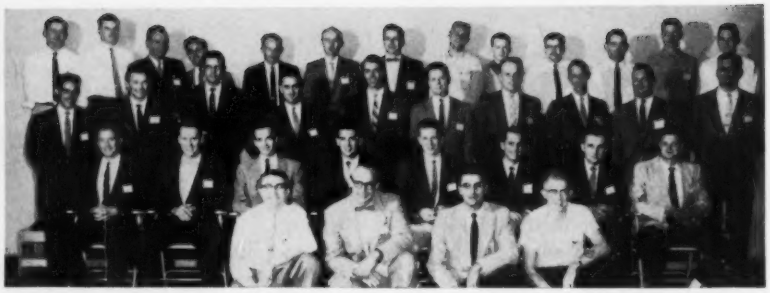
**Lightnin® Mixers**

**MIXCO fluid mixing specialists**

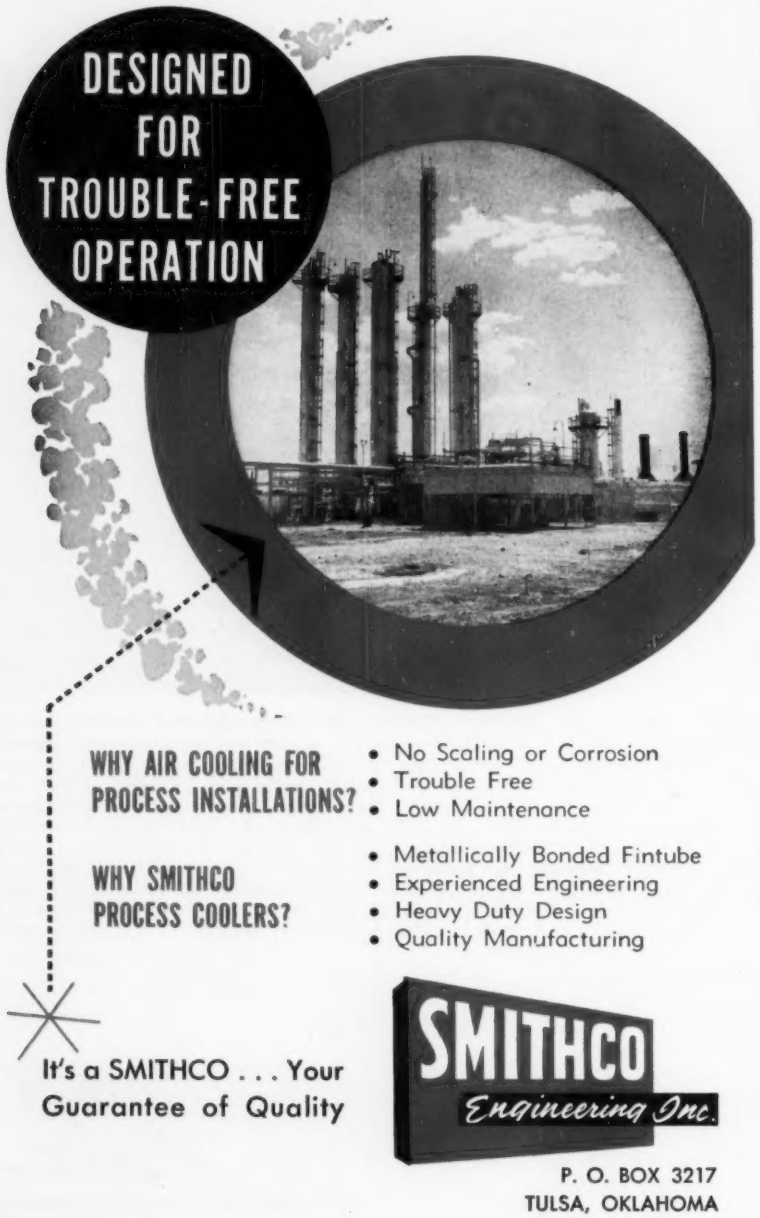
## Suppliers . . .

unit. Dr. Gerhart was appointed research director in 1947. He received a B.S. degree from Franklin and Marshall College in 1931 and a Ph.D. degree from Northwestern University in 1935. He was awarded an honorary D.Sc. degree by Franklin and Marshall College in 1953.

**FARRIS ENGINEERING CORP.** has formed a new manufacturing affiliate in England, Farris Engineering, Ltd. The company was formed in an agreement between Farris Engineering Corp., Farris Flexible Valve Corp. and Associated Automation, a subsidiary of Elliott-Automation of London.



**Pictured are 40 recently added sales and design engineers from Fisher Governor Co. plant and sales offices who attended a two-week Sales Fundamentals School in Marshalltown, Iowa, recently. Classes were conducted by sales, engineering and production personnel in design, maintenance and sale of Fisher equipment.**



**AMERICAN CYANAMID CO.'s** Pigments division has named **John Ludden, Jr.**, assistant manager of its Savannah, Ga., plant. A graduate of the University of West Virginia, Ludden joined Cyanamid in 1947 as an electrical engineer at the Willow Island, W. Va., plant. In 1956 he became assistant manager, Power department, Bound Brook, N. J., plant, where he was later made superintendent of utilities.

**BLAW-KNOX CO.** has named **James A. Kelly** manager of sales promotion for the Buflovak Equipment and Dairy Equipment divisions. He joined Blaw-Knox in 1950 as a member of the engineering staff, Dairy Equipment division. He became manager of advertising there in 1956 and, in 1958, was transferred to Buffalo to handle advertising and sales promotion for the Dairy and Buflovak divisions. Kelly attended the University of Minnesota and the Minneapolis School of Art.

**U. S. RUBBER CO.'s** Naguatuck Chemical division has appointed **Lawrence H. Bruce** sales manager of latices. He will supervise sales activities of all basic latices produced and sold by the division. Formerly assistant sales manager of colloidal products, he joined Naugatuck Chemical as a trainee in the production department in 1940. He has a chemical engineering degree from Northeastern University in Boston.

**THE BABCOCK & WILCOX CO.** will train the reactor operating crew of the nuclear-powered merchant vessel, the N. S. Savannah. The training program, to be conducted by the company's Atomic Energy division, Lynchburg, Va., is to last about 15 months. Its purpose is to provide a crew of skilled reactor operating engineers for the Savannah, and to train Coast Guard officers and Merchant Marine Academy instructors.

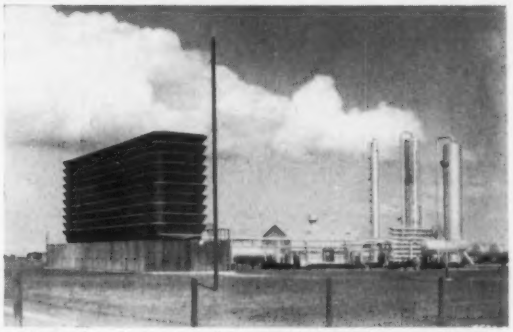
**HALE MANUFACTURING CO.** has appointed **Don Vossen** sales representative for Kansas. He has ten years of sales experience in the oil industry and several years of field experience.

**COCHRANE CORP.** has appointed, as its exclusive representatives in the Rocky Mountain area, The Hank Thurstin Co., Denver; C. H. Spencer & Co., Salt Lake City; S. C. Covington, Inc., Amarillo, Texas; and Associated Engineers, El Paso, Texas.

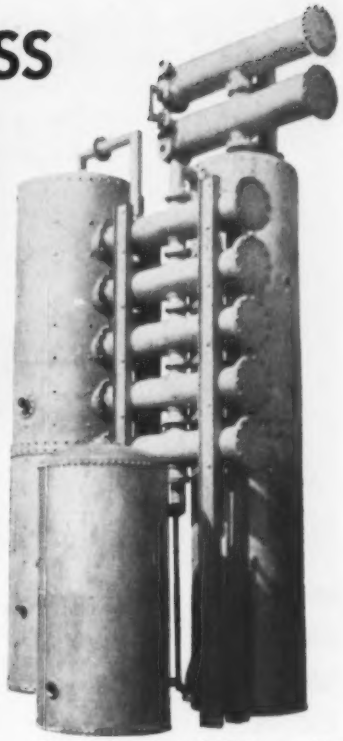
**MARSH INSTRUMENT CO.** has appointed **Mansur Storrs** New England district manager. A native of Massachusetts and a graduate of Thayer Academy and Principia College, he has been with the Marsh

*In Canada: Greey Mixing Equipment, Ltd., 100 Miranda Ave., Toronto 19, Ont.*

# GASOLINE PLANT PROGRESS



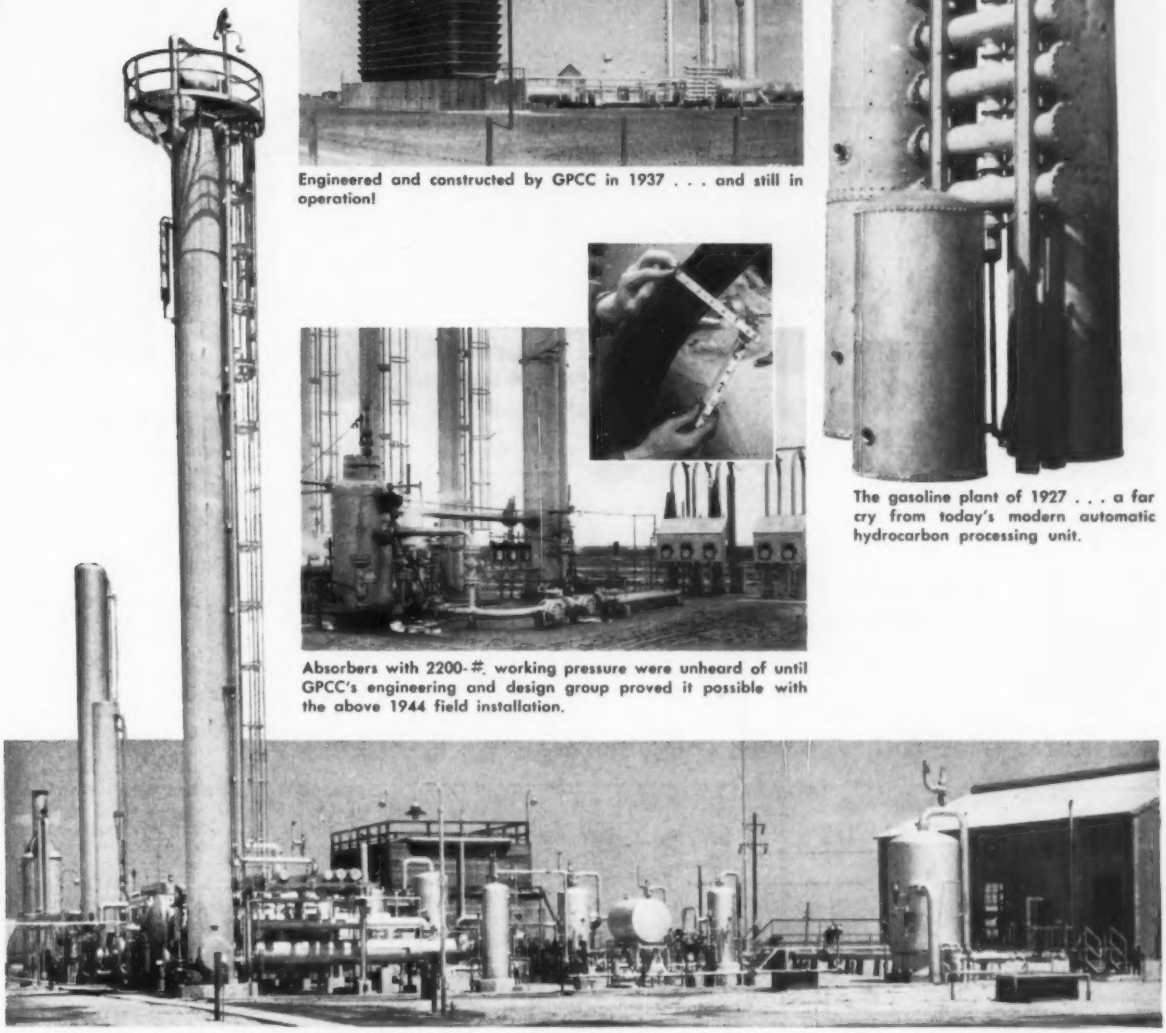
Engineered and constructed by GPCC in 1937 . . . and still in operation!



The gasoline plant of 1927 . . . a far cry from today's modern automatic hydrocarbon processing unit.



Absorbers with 2200-#. working pressure were unheard of until GPCC's engineering and design group proved it possible with the above 1944 field installation.



The plant of tomorrow, completed early this year by GPCC. Fully automatic, completely integrated and engineered for future expansion . . . a technical achievement of gasoline plant progress.

**An industry leader and pioneer . . .**

Plants engineered and constructed by Gasoline Plant Construction Corporation have set the pattern for hydrocarbon processing for nearly a quarter of a century. Experience gained in the installation of simple distillation units right on up thru fully automatic gasoline plants has made GPCC the engineering and construction leader in this field.

If you are planning a processing unit, TOMORROW's efficiencies and economies can be yours *today* with GPCC's facilities, experience and coordinated engineering staff at work for you.

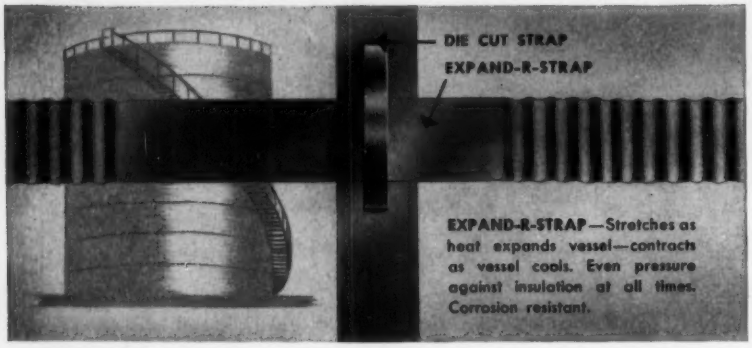
## GASOLINE PLANT CONSTRUCTION CORP.

**ENGINEERS • DESIGNERS • CONSTRUCTORS**

**ESPERSON BUILDING • HOUSTON, TEXAS**

5801

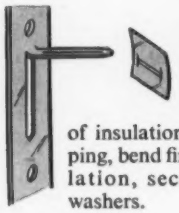
# NOW! One source for ALL your strapping needs


DIE CUT STRAP
EXPAND-R-STRAP
EXPAND-R-STRAP—Stretches as heat expands vessel—contracts as vessel cools. Even pressure against insulation at all times. Corrosion resistant.

**ALLOY STRAPPING**
For all types of insulation and varying corrosive conditions.

**TENSIONING TOOLS**
A full range of highest quality—easiest to use strapping tools.

**ALLOY SEALS**
Stainless steel, aluminum, galvanized, brass and monel seals for all widths and sizes of strapping.



**FINGER STRAPPING**
For all thicknesses and types of insulation. Apply as strapping, bend fingers, impale insulation, secure with spring washers.

**WIRE—STAPLES & PINS**
Available in all alloy grades.

**SPACERS & CLAMPS**

Especially designed for steam tracer lines.

**A.J. GERRARD AND COMPANY**
1956 Hawthorne Court • MELROSE PARK, ILLINOIS

☐ INSULATION CONTRACTORS—SEND FOR THIS 52 PAGE INSULATION MANUAL
☐ SEND DETAILS ON FOLLOWING PRODUCTS: _____

COMPANY _____
NAME _____ TITLE _____
ADDRESS _____
CITY _____ ZONE _____ STATE _____


## Suppliers . . .

sales staff five years. He will serve Maine, Vermont, New Hampshire, Connecticut, Rhode Island, and Massachusetts.

**Don L. Warner** was named district manager in the Philadelphia area. A graduate of Illinois Wesleyan University, he has been with the Marsh sales staff for ten years.

He will serve eastern Pennsylvania, New Jersey, District of Columbia, Maryland, and Delaware.

**BABCOCK & WILCOX CO.'s** Atomic Energy division has named **Dr. Lauchlin M. Currie** vice president. He began his association with the atomic energy program in 1943 as associate director of war research for the Manhattan district atom bomb project. Following World War II, he was a technical observer at "Operations Crossroads," during the Bikini atomic tests. Dr. Currie attended the first "Atoms for Peace" conference in Geneva, Switzerland, in 1955 as a member of both U. S. delegation and the U. N. Secretariat. A year later, he attended the Calder Hall Symposium in London, England, as consultant, and in 1958 was an observer at the second Geneva conference on the peaceful uses of the atom. He retired as vice president of the Union Carbide Nuclear Co. to accept his B&W post.

Currie

**J. C. HELLNER CO.** has been named manufacturer's representative in the Denver area for C. Lee Cook Co. **John C. Hellner** is president of the new organization. Since 1956 he has been with Darling Co., which represented C. Lee Cook in Denver from 1955 until the present. Hellner is a graduate of Pittsburgh Engineering school.

**MEXICO REFRACTORIES CO.** has appointed **J. Paul Maddox** manager of market research and development. He was previously a special representative, coordinating company sales to the refining industry and engineering firms. Before joining the organization in 1954, Maddox was with Laclede Christy Fire Brick Co. as vice president in charge of the Laclede Arch Co., Chicago.

**ARCAIR CO.** has appointed **Elmer Lehmkuhl** sales manager, responsible for marketing and sales of all Arcair products, Eastern division. **Martin Boyer** has been named sales promotion and advertising manager for Arcair. **Durward B. Vaught** has been appointed field representative in Virginia, Kentucky, southern West Virginia and other southern states.

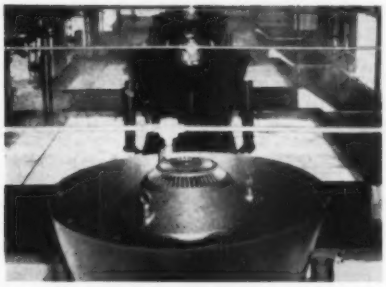
**MAINTENANCE ENGINEEERING CORP.** has appointed **E. M. Renfro** sales engineer for its Industrial Water Conditioning division. A graduate of Texas Technological College with a degree in chemical engineering, he is from Vernon, Texas.

**DRESSER INDUSTRIES, INC.'s** Manufacturing division has named **F. G. Fabian** president. He joined the division in 1953. Before this, he had spent three years with Booz, Allen and Hamilton, management

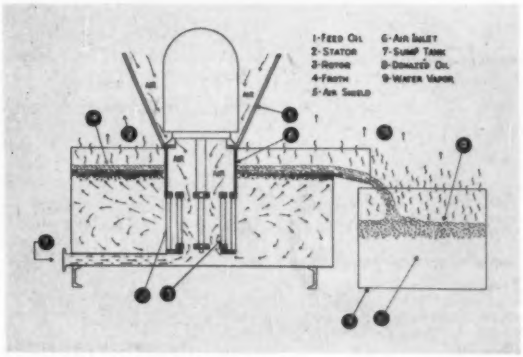
Hendrick will ship this Hydro-Dehazer pilot model to your refinery and demonstrate its low cost efficiency to you.

*Free demonstration in your plant will prove*

# HENDRICK HYDRO-DEHAZER GIVES YOU LOWEST OPERATING COST!



Hendrick Hydro-Dehazer is really economy-minded . . . removes moisture for only 25¢ per 1,000 barrels.




The Hendrick Hydro-Dehazer requires no compressed air, high heat, chemicals or other additives. As a result, it removes haze from refinery oils at very low cost — and quickly, too. This economy and speed have been proven in installations which show that Hendrick has the most efficient method — and the lowest operating cost — of all moisture-removal methods. Hendrick will be happy to prove its point in your plant. Just clip the coupon for more information.

Capacity of the Hendrick Hydro-Dehazer is rated at 400 bph for Diesel and No. 2 fuel oil at an inlet temperature of 130°F and a haze point of 35°F to 70°F.

**Hendrick**
MANUFACTURING COMPANY
**36 Dundaff Street, Carbondale, Pennsylvania**
***Sales Offices in Principal Cities***

**Perforated Metal • Perforated Metal Screens • Wedge Slot and Wedge Wire • Architectural Grilles • Mitco Open Steel Flooring • Shur-Site Treads • Armorgrids • Hendrick Hydro-Dehazer • Distillation Column Internals**

**HENDRICK MANUFACTURING COMPANY**
**36 Dundaff Street, Carbondale, Pennsylvania**

Gentlemen:

I am interested in learning more about the new Hendrick Hydro-Dehazer.

☐ Please arrange demonstration of the Dehazer Pilot Model.

☐ Please send technical data.

Name_____ Title_____

Company_____

Street_____

City_____ Zone_____ State_____



For more data on advertised products, use Readers' Service Cards, last page.

# EASTERN MIXERS

## mix fluids quickly . . . thoroughly

EASTERN'S COMPLETE LINE of fluid mixers range from fixed-mounted 40 H.P. turbines and heavy-duty propeller mixers to lightweight portables. Where fixed-mounted installations are not required, Eastern Portables offer versatility, ease of handling and long-term cost savings.

Portables are available with speeds of 420, 1125 and 1725 R.P.M., rated from 1/20 to 3 H.P. as standard, with variable speed and air-driven models also available. Motors in all standard types can be supplied in open drip-proof, totally-enclosed, or explosion-proof construction. Shafts and single or dual propellers are available in a choice of alloys for all service requirements. New optional ball-swivel clamp as illustrated, permits easy adjustment of mixer position in tank.

For a personalized analysis of your mixing problems, send details to Eastern engineers. A recommended solution will be furnished promptly and without obligation. For a helpful guide to mixing fundamentals, write for "Handbook of Fluid Mixing."

SIDE-ENTERING MIXERS
Handle the extra heavy-duty jobs in big tanks. Sizes ¼ to 30 H.P. Send for Bulletin 620.

TOP ENTERING MIXERS
Designed for heavy-duty applications requiring agitators from ¼ to 10 H.P. Send for Bulletin 620.

TURBINE MIXERS
Range of ¼ to 40 H.P. solve many special mixing problems. Send for Bulletin 1210.

NEW PORTABLE MIXER BULLETIN

*Eastern's improved line is included in the revised Bulletin No. 530.*

**Eastern INDUSTRIES, INC.**

Dept. A-2. Norwalk, Conn.

EASTERN INDUSTRIES MIXER DIVISION


## Suppliers . . .

consultants, Chicago. For a number of years he was with The Lindsay Corp. as vice president, and Bryan Manufacturing Corp. in engineering, administration and sales capacities. Fabian attended Choate School and Yale University, from which he holds a B.S. degree in industrial engineering. He is a member of ASME, SAE, AGA and AWWA.

**J. B. Merritt left, BJ President, congratulates A. M. Birnie on promotion.**

**BJ SERVICE, INC.** has named **A. M. Birnie** vice-president and manager of sales, with offices in Ft. Worth. Since 1951 he has been executive vice-president of Security Engineering Co., Dallas, in charge of all field operations. Previously, he was general sales manager of Welex, Inc.

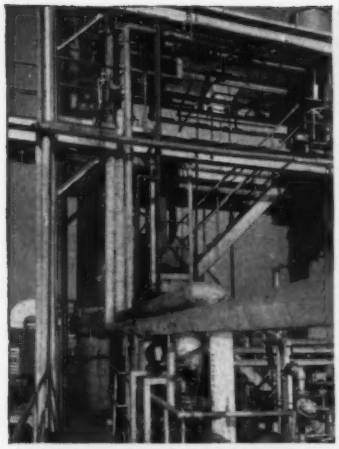
**INTERNATIONAL LUBRICANT CORP.** has named **B. G. Symon**, manager of Shell Oil Co.'s Industrial Products department, general sales manager, New Orleans. International Lubricant is a Shell subsidiary. A mechanical engineering graduate from the University of Missouri, Symon began his career with Shell in 1928 as assistant to the manager of the Lubricants department, St. Louis.

**ETHYL CORP.'s Merrill J. Anderson** has been promoted to chief automotive engineer, Central region, Chicago. He has been with the Eastern region in New York. Anderson has a mechanical engineering degree from the University of Illinois and is a member of the Society of Automotive Engineers.

**MONSANTO CHEMICAL CO.'s** Lion Oil Co. division has named **Joe A. Keepers** manager of petrochemical sales, Houston. He has served in New Orleans as senior project specialist in Lion's Development department since August, 1957. Keepers originally joined Monsanto's Plastics division, Production department, Texas City, in 1950. With the Research-Development department from 1953 until joining Lion in 1957, he has a B.S. degree in chemical engineering from the University of Utah.

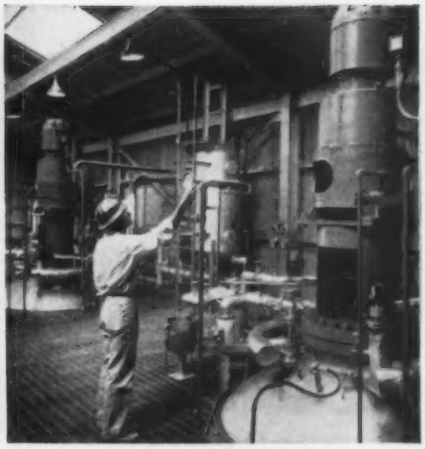
**THE THOMPSON-RAMO-WOOLDRIDGE PRODUCTS CO.** has been designated a division of Thompson Ramo Wooldridge, Inc. The company's management includes **Dr. Joseph F. Manildi**, general manager; **Dr. Montgomery Phister, Jr.**, director engineering; **Raymond Jacobson**, director of marketing; and **Robert J. Barrett, Jr.**, controller.

**H. K. PORTER CO. INC.'s** Quacker Rubber division has named **S. William Riley** chief engineer. He will be responsible for all engineering at the Philadelphia plant. Before joining Quacker last January, Riley

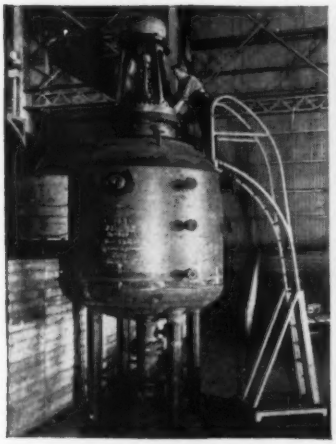


RDC Countercurrent Extraction Column Handling a Total Flow of 2500 GPH

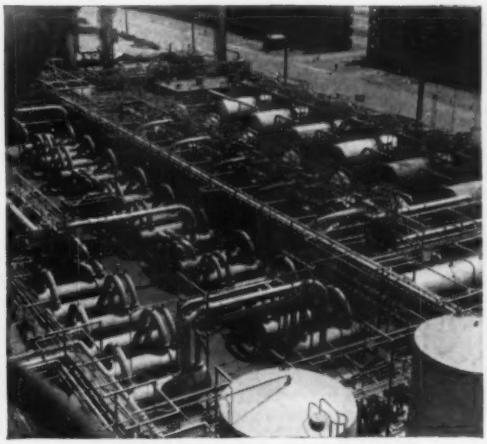
Side Entering Propeller Mixer Blending Asphalt Cutback Products



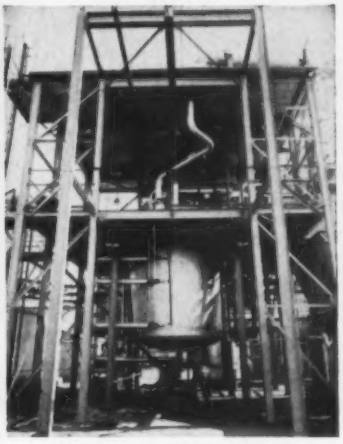
Typical Polyethylene Reactor Assembly



Three Stage Continuous Butane Isomerization Unit



Series of Three Stage Treaters and Settlers in CAA—Butadiene Extraction



7800 Gallon Outdoor Polyester Resin Reactor

# for petrochemicals here is TURBO on the job

No mixing service is too large or too small for our staff of designers, engineers and skilled craftsmen, nor for the facilities of our plants. In support of the *high*-production, *low*-maintenance equipment shown here is more than 40 years of specialization in this field. Back of this equipment, too—a testing and research laboratory that enables our designers to custom-build Turbo-Mixers for *your* individual requirements.

Send for descriptive information showing how Turbo-Mixers can increase your production efficiency at lower cost.

**FOR DETAILED INFORMATION AND USEFUL DESIGN DATA, SEND FOR THE FOLLOWING BULLETINS:**

Please send me the following Turbo-Mixer Bulletin (s):

General Turbo-Mixer Bulletin_____

RDC Extraction Column Bulletin_____

Side Entering Propeller Mixer Bulletin_____

Absorption & Oxidation Bulletins_____

TURBO-MIXER GENERAL AMERICAN

**TURBO-MIXER DIVISION**
**GENERAL AMERICAN TRANSPORTATION CORPORATION**

Sales offices: 380 Madison Avenue, New York 17, New York • General Offices: 135 South LaSalle Street, Chicago 90, Illinois • Offices in all principal cities



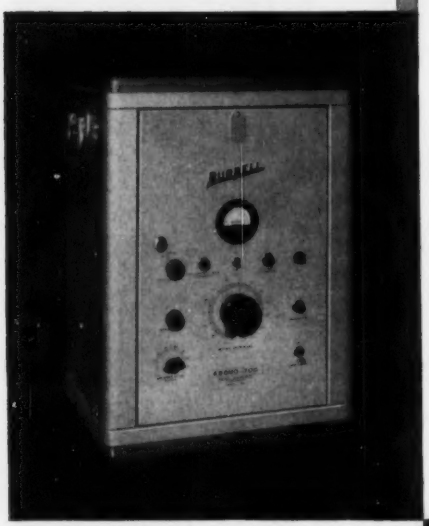
For more data on advertised products, use Readers' Service Cards, last page.

BURRELL *"For Scientists Everywhere"*

# THE KROMO-TOG®

**MODEL K-3**

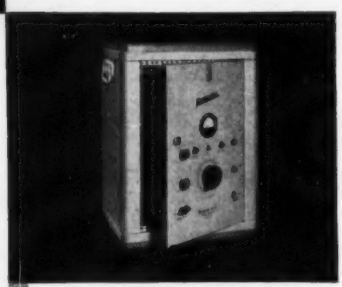
for gas and vapor chromatography



The Kromo-Tog, Model K-3, is a compact, low-cost, chromatographic instrument for the speedy routine analyses of most gases and liquids of any boiling point to 370° C., and over.

Accessories may be added to the basic "build-up" unit. Panel-door and sides open for free access to all components. Extremely easy to install and use, this model may be bench or panel-mounted anywhere.

- **SEPARATE COLUMN TEMPERATURE CONTROL**
- **ACCESSIBLE COLUMNS FOR RAPID CHANGE**
- **HIGH SENSITIVITY OF DETECTOR CELL**
- **FRACTIONS AND CUTS EASILY COLLECTED**



**THE BURRELL KROMO-TOG**

**Model K-3**

Basic chromatographic unit,
less recorder or power source for cell.
Operates at 115 volts, 60 cycles.

**Burrell Cat. No. 340-31.....$875.**
F.O.B. Pittsburgh, Pa.

**COMPACT SIZE**
Only 24" x 16" x 13"

**BUILD-UP DESIGN**
Accessories can be added.

***Ask for Bulletin 831***

**BURRELL CORPORATION**

*Scientific Instruments and Laboratory Supplies*

**2223 FIFTH AVENUE, PITTSBURGH 19, PA.**

## Suppliers . . .

was design engineer with McNeil Machine and Engineering Co. and superevising engineer with B. F. Goodrich Co. In the rubber industry for 16 years, he graduated from Ohio State University with a B.S. degree in mechanical engineering.

**LEEDS & NORTHRUP CO.** has created three new vice presidencies. One new post, vice president of technical affairs, will be held by **Nathan Cohn,** formerly manager, Market Development division, Marketing department. He will be responsible for supervision of the Research and Development department, the Engineering department, and the Patent division. The present director of marketing, **Donald E. Moat,** becomes vice president of marketing, while retaining his former function. The present director of manufacturing, **John F. Quereau,** retains that function and becomes vice president of manufacturing.

**Cohn**

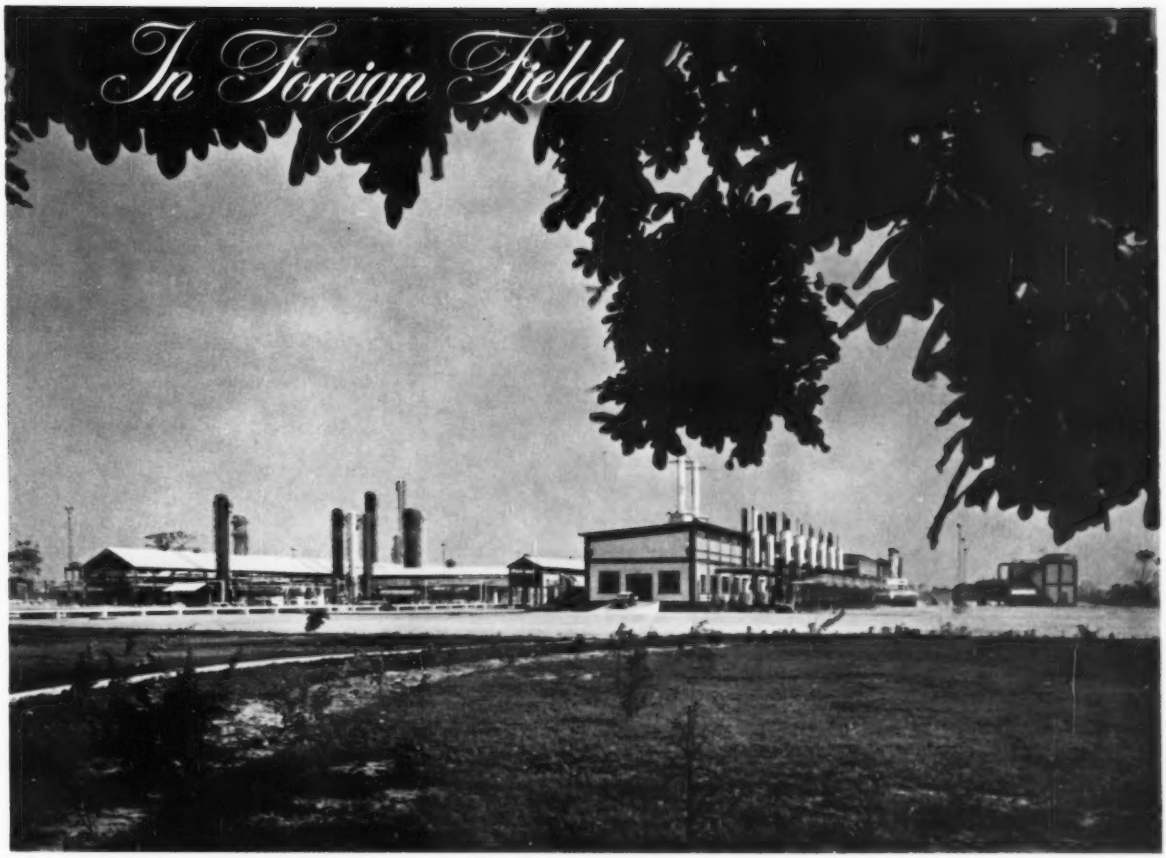
**JEFFERSON CHEMICAL CO.** has named **R. E. Werley, Jr.,** sales manager. A 1948 graduate of Lehigh University, he has been Jefferson's mid-Western regional manager since 1956. He joined the company in 1952 as a salesman for the New England territory and later was made district sales manager, Chicago.

**BENDIX AVIATION CORP.'S** computer division has named **C. Allen Skinner,** former independent oil operator, sales engineer for the Southwest regional office. Formerly district manager for Power Specialty Co., Dallas, and assistant to the president of Cambridge Tile Co., Cincinnati, he will locate in Dallas. He is a graduate of the U. S. Naval Academy.

**BECKMAN INSTRUMENTS, INC.** has named **William G. Newton** corporate industrial engineering manager. Formerly chief industrial engineer for the Scientific and Process Instruments division, he will coordinate industrial engineering functions of the company's operating divisions and a domestic subsidiary. Before joining Beckman in 1955, he was chief industrial engineer for General Aniline and Film Corp.

**GENERAL ANILINE & FILM CORP.** has named **Harold G. Shelton,** formerly director of marketing, general manager of the Dyestuff & Chemical division. He joined General Aniline in 1945 as sales manager, Antara Chemicals Sales department, Dyestuff & Chemical division. In 1957 he was appointed marketing director of the division in charge of all sales activities.

**DOVER MANUFACTURING CO.** and J. F. Pritchard and Co. have formed a new company, Pritchard of Calif., to manufacture cooling towers. Officers of the merged firms include **J. F. Pritchard, Jr.,** president; **Karl E. Johnson,** executive vice president and **P. S. Lyon,** secretary-treas-




## PETROLEOS MEXICANOS

# *Gas Processing Plant*

## CIUDAD PEMEX, MEXICO

HUDSON services in foreign fields are flexible to the owners' requirements, including design and building of the entire project, or process design, mechanical design, purchasing or construction. Illustrative is the above pictured major gas processing project in Mexico, designed to extract 30,000 barrels of liquid products from 500 million cubic feet per day of gas. Process design, mechanical design, and procurement of equipment was entrusted to HUDSON. The plant was constructed by Petroleos Mexicanos near the Yucatan Peninsula in Mexico.

In Mexico, Canada, South America, Europe, and the Near East; in deserts, mountains, and jungles; in locales in some cases without established rail, road, or water transportation; working at times with inexperienced labor forces of mixed nationalities; under climatic extremes, HUDSON has completed major oil, gas, chemical, and heavy mineral processing projects – on time – and to the complete satisfaction of the owners.

This varied experience from Tierra del Fuego to Canada, from Pakistan to Peru, qualifies HUDSON to complete with speed and facility major processing projects under the most difficult conditions in any part of the world.

*DESIGNERS AND CONSTRUCTORS OF PROCESS PLANTS FOR THE OIL, GAS, CHEMICAL, AND MINING INDUSTRIES*

**HUDSON**

**ENGINEERING CORPORATION**

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Mobil

*93 years a leader in the*
*100 years of the Oil Industry*

SOCONY MOBIL OIL COMPANY, INC., Domestic Affiliates: MAGNOLIA PETROLEUM CO., GENERAL PETROLEUM CORP.

## Suppliers . . .

urer. The four major divisions of the company will be directed by **H. R. Cohen**, controller; **P. A. Frohwerk**, manager of research and engineering; **N. W. Kelly**, manager of manufacturing and **W. R. Roeyer**, general sales manager. Administration headquarters are at the present Pritchard of Calif. offices, Kansas City, Mo. Manufacturing plants are at Merced, Calif. and Independence, Mo.

**BLAW-KNOX CHEMICAL ENGINEERING CO., LTD.,** London, is a newly-formed Blaw-Knox affiliate. The new company will serve and develop overseas markets for engineering and construction services in process design and development, and the design and installation of chemical, petroleum, and processing plants of all kinds.

Nelson

Wood

Rose

Green

**THE ENJAY COMPANY, INC.,** has elected **John E. Wood, III,** general manager of the Chemical Products department of Esso Standard Oil Co., president of Enjay. New vice presidents are **Karl J. Nelson, Harold J. Rose** and **A. Donald Green.**

Wood, with the company since 1939, has a Ph.D. degree in organic chemistry from Massachusetts Institute of Technology. Nelson, head of Enjay's Sales department since last July, has been with the company since 1939 as a chemical engineer, product coordinator, product manager and sales manager. Rose, head of the Products Management department since August, has been with the company since 1942. He has a M.S. degree in organic chemistry from the University of Kentucky. Green, who joined the company as a chemical engineer in 1930, has headed the New Projects department since September. He served at Esso's Baton Rouge refinery and the Research center, Linden, N. J. Before joining Enjay, he was deputy coordinator of chemicals research.

**THE A. O. SMITH CORP.** has acquired Erie Meter Systems, Inc., Erie, Pa. **H. G. Smith,** who will be president and general manager of Erie, said the sales organization of each company will be combined


# CHALLENGING CAREERS IN APPLIED SCIENCE

*exploring the frontiers of computer systems applications*

*problem:* How to use mathematical techniques in developing optimal flood patterns for proposed water flood projects, primary depletion predictions, and optimum well spacing.

*problem:* How to apply linear programming techniques to processing operations of a huge oil refinery to develop more profitable operating methods.

*problem:* How to use computers to solve such marketing research problems as service station locations, warehouse locations, and predictions of sales.

These are typical of the challenging problems that you will encounter in applied science at IBM. A leader in the dynamic electronic systems field, IBM is seeking select, creative scientists, mathematicians, and engineers—with or without computer knowledge—ready to undertake important career assignments. You may be the person we're looking for . . .

- If you have a sound mathematical background and considerable petroleum experience.
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- If you wish to apply your knowledge of mathematics and science to the task of solving—with high-speed electronic computers—important problems of the petroleum industry.
- If you have a facility for communicating with others and for translating complex problems into everyday English.
- If you want the opportunity to exercise a free hand in assignments requiring fresh thinking, new approaches, great creativity.

IBM Applied Science assignments entail research into petroleum problems relating to electronic computer applications. How to reduce business problems to pure mathematical language. How to translate that language to a universally feasible computer application. "How" is the key word . . . and to decide how, IBM's vast resources and facilities are placed at your disposal.

These openings are in the Texas area. For more information, please write, outlining background and interests, to:

**Mr. L. C. Hubbard, Dept. 633A**
**International Business Machines Corp.**
**3424 Wilshire Blvd.**
**Los Angeles 5, Calif.**

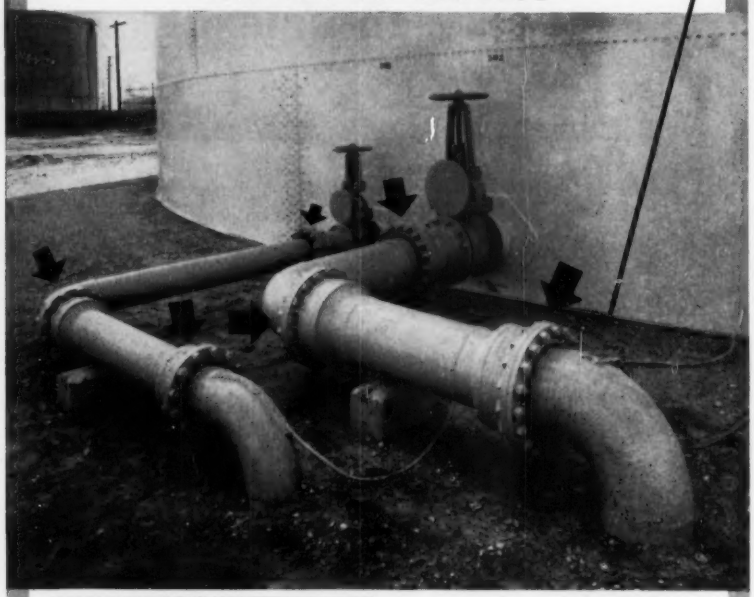
IBM®

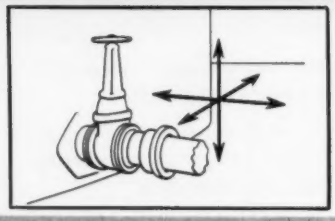



For more data on advertised products, use Readers' Service Cards, last page.

# Unlimited Flexibility!

—PROVEN IN SERVICE





**Allows 6-Way Movement!**

**Freedom of movement in any direction is readily possible with these *ball joint connections* of 12" pipe (right) and 8" pipe (left) to 80,203 bbl. tank shown in above photo. (Photo: SHELL OIL COMPANY, Dominguez Refinery, Wilmington, Calif.)**

## Barco Ball Joints—

**provide complete protection against FIRE, EARTH SHOCK, TANK SETTLING**

The rapidly increasing use of Barco's new large size Flexible Ball Joints in California, and other locations, is significant for several key reasons:

1. **Fire-Safe. The joints have passed rigid fire and water spray tests.**
2. **Unlimited flexibility and movement.**
3. **Long service life without maintenance.**
4. **Joints insulate against electrolysis as well as provide movement in all planes.**

Such installations protect piping, valves, and tanks from earth movements, shifts, shocks, and earthquakes. They allow for *tank settling* or *tilting* as well as for *thermal expansion* or *contraction of piping* leading to tanks without creating strain. In case of fire, the joints are "fire safe."

For detailed information, WRITE FOR CATALOG 215B. Joints available in steel with flanged or welding ends. 15° angular flex.

PRODUCTS BACKED BY EXPERIENCE
BARCO
ANNIVERSARY
1909 50TH 1959

**BARCO MANUFACTURING CO.**
5428 Hough Street • Barrington, Illinois

*The Only Truly Complete Line of Flexible Ball, Swivel, Swing and Rotary Joints*
**In Canada: The Holden Co., Ltd., Montreal**


## Suppliers . . .

and operated as one organization, and product lines of the two companies will be integrated. **L. F. Smith,** executive vice president of Erie, will manage Pennsylvania plant operations.

**MONSANTO CHEMICAL CO.'s** Lion Oil Co. division has promoted **N. Patrick Hudson** to the assistant sales manager of protective coatings. He was formerly administrative assistant to the manager of protective coatings. Hudson graduated from Ouachita College in 1949 with an A.B. degree in business administration.

**CLARK BROS. CO.** has named **John V. James** vice president of finance. For the past 15 months he has been assistant comptroller for Dresser Industries on a staff assignment with Clark Bros. Since last June he has been financial assistant to the executive vice president. James is a graduate of the Wharton School of Business Administration.

**KEROTEST MANUFACTURING CO.** has appointed **Edward N. Wrenshall,** general manager. He will direct and co-ordinate all activities of both the steel and brass divisions of the valve manufacturing company.

**Wrenshall**

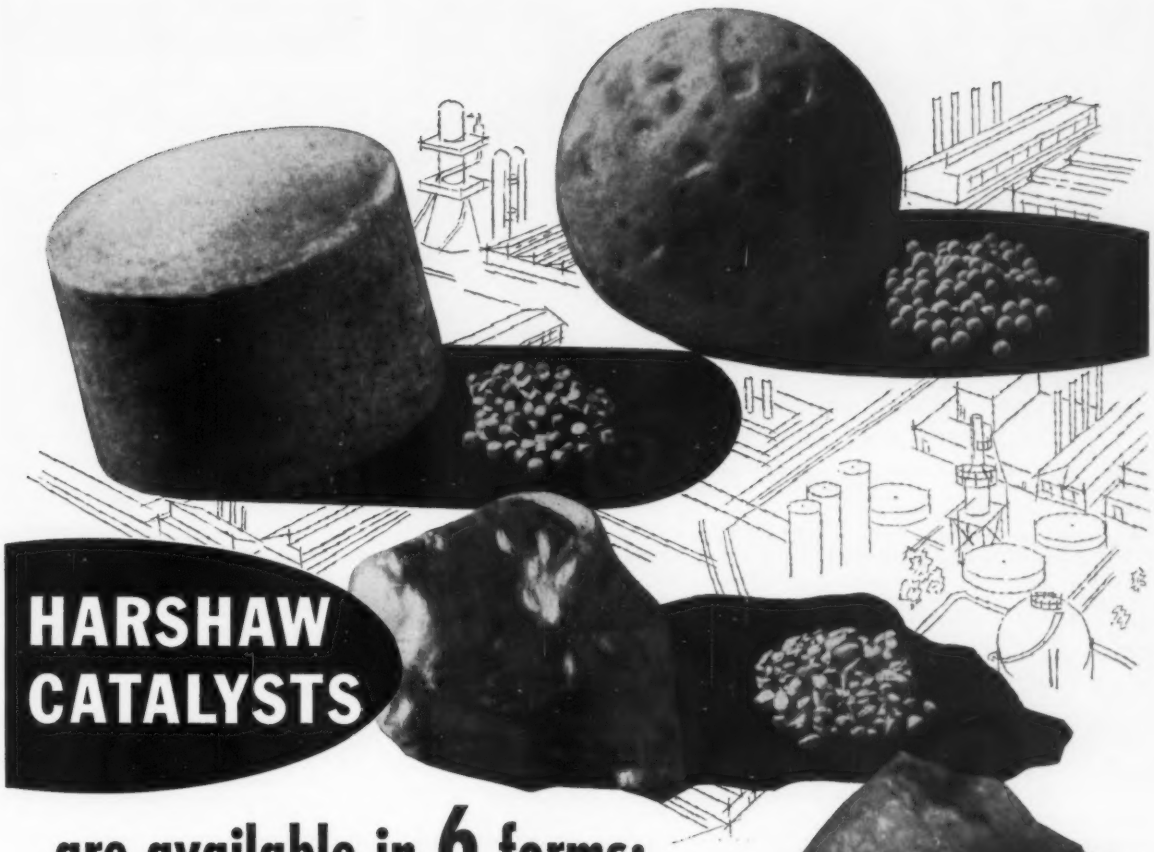
His background includes ten years of service as director of purchases at Miller Printing Machinery Co., Pittsburgh, one year as director of purchases at Kerotest and two years as general superintendent of Tube City Iron and Metal Co. He is a former member of the Pittsburgh chapter of the National Purchasing Agents Association. Wrenshall attended Kiski and Washington and Jefferson colleges.

**RAYMOND INTERNATIONAL, INC.,** has formed Raymond International (U.K.), Ltd., a wholly owned subsidiary with headquarters in London.

**W-K-M,** a division of ACF Industries, Inc., has appointed **M. R. Chance** chief metallurgist, responsible for all metallurgical functions. He previously spent six years with Reed Roller Bit Co., Houston. Chance has a B.S. degree from the University of Maryland, and is a registered professional engineer.

**FLEXONICS CORP.** has established Flexonics Research laboratories, a new division, at Elgin, Ill. Located at the company's Research and Development center, it will provide testing and development service on a contract basis to industry and to developmental agencies of the government. **D. Wendell Fentress,** vice president of research and development, who has headed Flexonics' research activity since 1937, will manage the new division.

**THE CARPENTER STEEL CO.'s** Alloy Tube and Webb Wire divisions have appointed **William H. Trout** divisional controller. He was formerly auditor and systems supervisor at the company's main office in Reading, Pa., and has 19 years' experience in the Operating and Financial depart-



# HARSHAW CATALYSTS

## are available in 6 forms:

**TABLETED • EXTRUDED • GRANULAR**
**SPHERES • FLAKES • POWDERS**

We'll assist you in developing the best and most economical catalyst for your needs. Our more than 20 years catalyst experience and acres of production and research facilities are ready to work for you. Harshaw produces carloads of catalysts every week —this capacity guarantees prompt shipment of your catalyst order.

**PREFORMED CATALYSTS**
*to fit special process requirements*

Hydroforming • Cyclization • Oxidation • Dehydrogenation
Dehydration • Desulphurization • Alkylation • Hydrogenation,
Hydro treating • Chlorination

**CATALYTIC CHEMICALS SUPPLIED BY HARSHAW**

| | | |
|---|---|---|
| Aluminum Nitrate | Metallic Soaps (Cobalt, Manganese) | |
| Manganese Nitrate Solution | Cobalt Nitrate | Copper Nitrate |
| Nickel Carbonate | Nickel Formate | Nickel Nitrate |
| Nickel Sulfate | Sodium Methoxide | Zinc Nitrate |

Our experienced technical staff will assist you in developing the best and most economical catalyst. If you have a catalytic process in the development or production stage, a discussion with us may prove beneficial.

*Write for Free Book*

HARSHAW

THE HARSHAW CHEMICAL CO.
Chicago • Cincinnati • Cleveland • Detroit
Houston • Hastings-On-Hudson, N.Y. • Los Angeles
Philadelphia • Pittsburgh



For more data on advertised products, use Readers' Service Cards, last page.

A-W Hydraulic Crane speeds heavy valve assembly to maintenance shop at Sun Oil's Toledo refinery.

# Austin-Western Hydraulic Crane proves safe, fast, economical in 3 years' operation at Sun Oil refinery

"Safety was one of the main reasons we purchased an Austin-Western Hydraulic Crane 3 years ago for refinery maintenance. The positive hydraulic control of boom and hoist on this self-propelled precision crane protects personnel and prevents accidents that result from makeshift methods of lifting and moving," we are told by Sun Oil's Toledo refinery.

**Dispatcher Records Provide Proof**

"Operating time and use are recorded by a vehicle dispatcher. His records provide positive proof that the A-W is safer, easier, faster, more mobile, and less costly than large cranes. It costs less per shift than half of one man's wages.

"We discover new uses daily for it. It goes where big cranes can't. With a ½-yd. bucket attachment, it is even used to pour concrete. It helps maintain our truck fleet, too. It handles engines and tires and, with all-wheel drive, it doubles as a wrecker and towing vehicle.

**Does Difficult, Dangerous Jobs Better**

"Not only does the A-W do so many difficult jobs better, but it does them more safely and easily. For instance, crane and operator can safely remove heavy gas compressor pistons and transport them to the maintenance shop in 1 hour. This saves 2½ man-hours plus 2 hours' time for truck and driver.

"Our big 10-ton crane couldn't reach a 1000-lb., 6-ft.-long crude oil pump element. But the A-W, with all-wheel steering, maneuvered right up to the pump, removed the element, and delivered it ¼ mile away in less than an hour.

"The A-W is so useful we hired a night operator. The crane pays for his wages with the time it saves by preparing jobs for the next day.

**Works 500 Shift-Days per Year**

"Our A-W averages two shifts daily—a total of 500 shift-days a year. Often it works a third shift for overtime work or to shorten downtime on equipment. It's easy to operate. A number of our maintenance men can put it through its paces.

"This inexpensive hydraulic crane is another modern tool to help our men do their work more safely, more efficiently, and at lower cost!"

Send for the complete Sun Oil Toledo refinery story—Gould Certified Report No. 5712. Write today.

Austin 100th YEAR Western
CONSTRUCTION EQUIPMENT DIVISION, AURORA, ILL.

BALDWIN · LIMA · HAMILTON

Power graders • Motor sweepers • Road rollers • Hydraulic cranes


## Suppliers . . .

ments. He is a member of the National Office Management Association, the Institute of Management Sciences, and the American Association of the Advancement of Science.

**AMERICAN CYANAMID CO.'s** Dyes department has appointed **M. H. Mettee** sales manager. He will supervise the marketing of all dye products. Mettee joined Cyanamid in 1932 and has served in several sales managerial capacities, primarily in dyes marketing. Most recently, he has been manager, Intermediates department. He is a graduate of The John Hopkins University.

**ETHYL CORP.** has employed **J. Reid Jackman** as a member of the Research laboratories, Refinery Technology division, Detroit. He has a B.S. degree in petroleum refining from Tulsa University. Before joining Ethyl, he was with DX-Sunray Oil Co.

**NATIONAL ALUMINATE CORP.** has named **Heman R. Powers** executive vice president. He joined the company 24 years ago as a laboratory assistant, moved into sales and sales management positions, and was elected a vice president in 1955. In 1956 he became general manager, Industrial division.

**MINNEAPOLIS-HONEYWELL REGULATOR CO.'s** Brown Instruments division in Philadelphia has appointed **Warren W. Lee** Eastern region sales supervisor for systems engineering. He joined Honeywell in 1950 after receiving a B.S. degree in mechanical engineering from Oklahoma A & M College. He is a graduate of Harvard University's school of business administration.

**CONSOLIDATED ELECTRODYNAMICS CORP.** has appointed **Charles C. Snider** director of sales. CEC sales manager the past three years, he joined the company as a field engineer in the Washington, D. C., district sales office in 1952. He became manager of the Southeastern Regional office in Atlanta in 1953, and sales manager in 1955. He has a B.S. degree in chemical engineering from Northwestern University.

**ACF INDUSTRIES, INC.** has elected **Henry A. Correa** vice president of marketing. Formerly vice president of foreign operations, he will continue to supervise that activity, and, will work with the company's operating divisions in inter-divisional marketing activities in both government and civilian-industrial areas.

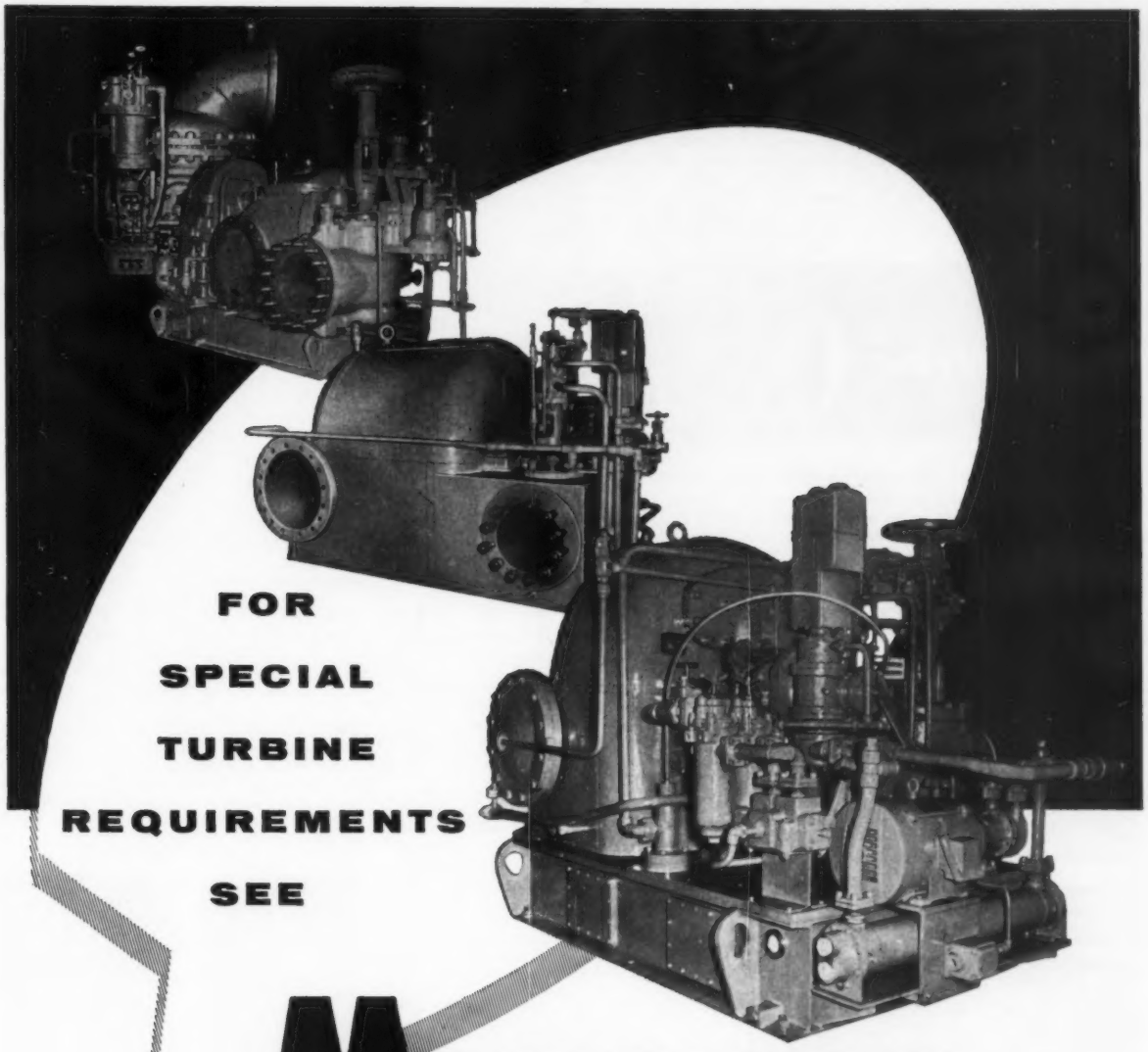
Before coming to ACF last January, Correa was sales manager for the International division, Bendix Aviation Corp. He is a graduate of St. Louis University.

**WALWORTH CO.** has named **Alfred F. Johnson** assistant chief engineer, responble for the administration of general engineering design and product control in the Engineering department. He was formerly with the Forge & Fittings division, H. K. Porter Co., Inc., as chief engineer and works manager.

**ALLIS-CHALMERS CO.'s** Industries group has appointed **Alan Purchase** manager of petroleum and chemical sales, and **W. G. Lowe** manager of industrial sales, San Francisco district. Purchase, formerly manager of industrial sales, San Francisco,



For more data on advertised products, use Readers' Service Cards, last page.



FOR SPECIAL TURBINE REQUIREMENTS SEE

# Murray TURBINES

- Low Inlet Pressures
- High Back Pressures
- High Speeds
- Variable Speed Ranges
- Precise Control
- Multi-Valve Designs
- Double End Gear Drives
- Vertical Shaft Turbines

***Our nearest representative will help you solve your turbine requirements. His name gladly sent on request.***

**MURRAY IRON WORKS COMPANY • BURLINGTON, IOWA**

**Builders of Steam Power Equipment for Nearly a Century**

## Suppliers . . .

joined Allis-Chalmers in 1949. He has a mechanical engineering degree from the University of California. Lowe had been sales representative in the Seattle district since 1953. He has a M.S. degree in electrical engineering from the University of Washington.

**CONSOLIDATED ELECTRODYNAMICS CORP.** has changed the name of its Central Manufacturing divisions to Electro Mechanical Instrument division and appointed **A. P. Stuhrman** director. Stuhrman was appointed manager of the Central Manufacturing division in August, 1957. He joined the company a year earlier as director of quality control. He has a B.S. degree in mechanical engineering from the University of Florida.

**CHEMETRON CORP.'s** Girdler Catalysts division has named **Edmund W. Dugan** assistant director, General Industrial Equipment and Components division, Business and Defense Services Administration, U.S. Department of Commerce. He is on a six-month assignment in Washington, providing technical guidance for defense mobilization of industrial resources under the amended Defense Production Act of 1950. A member of the National Defense Executive Reserve of the U.S. Department of Commerce, Dugan has held various executive and administrative assignments in Girdler Catalysts. He previously served three years as director of priorities, and as Washington representative for the company's Girdler and Tube Turns divisions. He is a member of the American Association for the Advancement of Science, the American Management Association, and the Armed Forces Chemical Association.

Dugan

**BUCYRUS-ERIE CO.** has elected **Robert G. Allen** president in charge of all operations. He joined Bucyrus-Erie in May 1957 as vice president and was made executive vice president in November of that year.

**THE FAIRBANKS CO.** has assigned **F. H. Wilson** to the Delaware, Maryland and District of Columbia sales territory. He has ten years' experience, having previously covered the western Massachusetts territory working out of the Boston branch office.

Jones

McDaniel

**GARDNER-DENVER CO.** has elected **Charles M. George** vice-president and general manager for operations. **Aubrey H. Jones,** vice-president and director of the Export division, has been elected president of Gardner-Denver International, C. A., a new subsidiary. **Kenneth J. McDaniel,** director of personnel, has been elected secretary.

George

George has held various sales and administrative posts in his 30 years with the company. He has been secretary since 1955. Jones joined Gardner-Denver as a salesman at Los Angeles in 1927. He has been a vice president since 1953. McDaniel, a University of Illinois graduate, joined the company in 1947. He has been director of personnel since 1954.


## Petroleum Refiner Classified Ads

**Petroleum Refiner New Classified Rates**

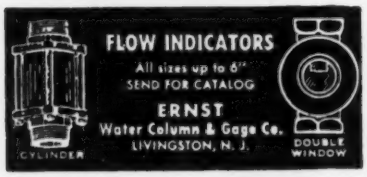
**RATES: Regular Classified** (undisplayed) **set in this type: 20 cents per word. Minimum charge, $4. Blind box address in our care counts six words. Replies forwarded without charge. Display Classified ads, set in suitably larger type with ruled border, $12.50 per column inch. Ten percent discount for two or more insertions of same copy in consecutive issues. All Classified ads payable in advance. Copy deadline: 25th of month preceding date of issue. Send copy and checks to: Classified Advertising, Petroleum Refiner P. O. Box 2608, Houston, Texas.**

* * * * * * * * * * * * * * * *

### FOR SALE

**Specify SAUEREISEN**
**ACIDPROOF CEMENTS—COMPOUNDS**
**FOR**
Tanks, Sewers, Stacks, Floors
Technical cements for all purposes.
*Send sketches or samples*
Sauereisen Cements Company · Pittsburgh 15, Penna.

**When you see a large chimney think of Sauereisen Cements.**




■ Sales: Engineered Equipment To Refining and Petrochemical Industry. Technical background. Established 20 years Tulsa. Expansion Oklahoma, southern Kansas, Texas Panhandle proposed. Answer Box 307-R, PETROLEUM REFINER, Houston, Texas.

■ Four Cylinder York Ammonia Compressor 300 ton Capacity at Zero Degrees F. used 6 months cost $38,000.00 Will sell for $13,300.00. Box 308-R, PETROLEUM REFINER, Houston, Texas.

### WANTED

■ **PETROLEUM REFINER back issues and files wanted to buy for cash, also other technical journals, P. R. Ashley, 27 East 21, New York 10, N. Y.**

■ CLEANING EQUIPMENT—for plant maintenance and tank cleaning. Hot "jet-stream" cleaning with Sellers Hydraulic Jets. Send for Bulletin 424-B Sellers Injector Corp., 1603-L Hamilton Street, Philadelphia 30, Pa.

### HELP WANTED

■ SALES ENGINEER for Radioactive Sources & Tracers and equipment to Petroleum & Chemical Industry in Louisiana, Texas, Oklahoma area. Need experienced capable man. Box 309-R, PETROLEUM REFINER, Houston, Texas.

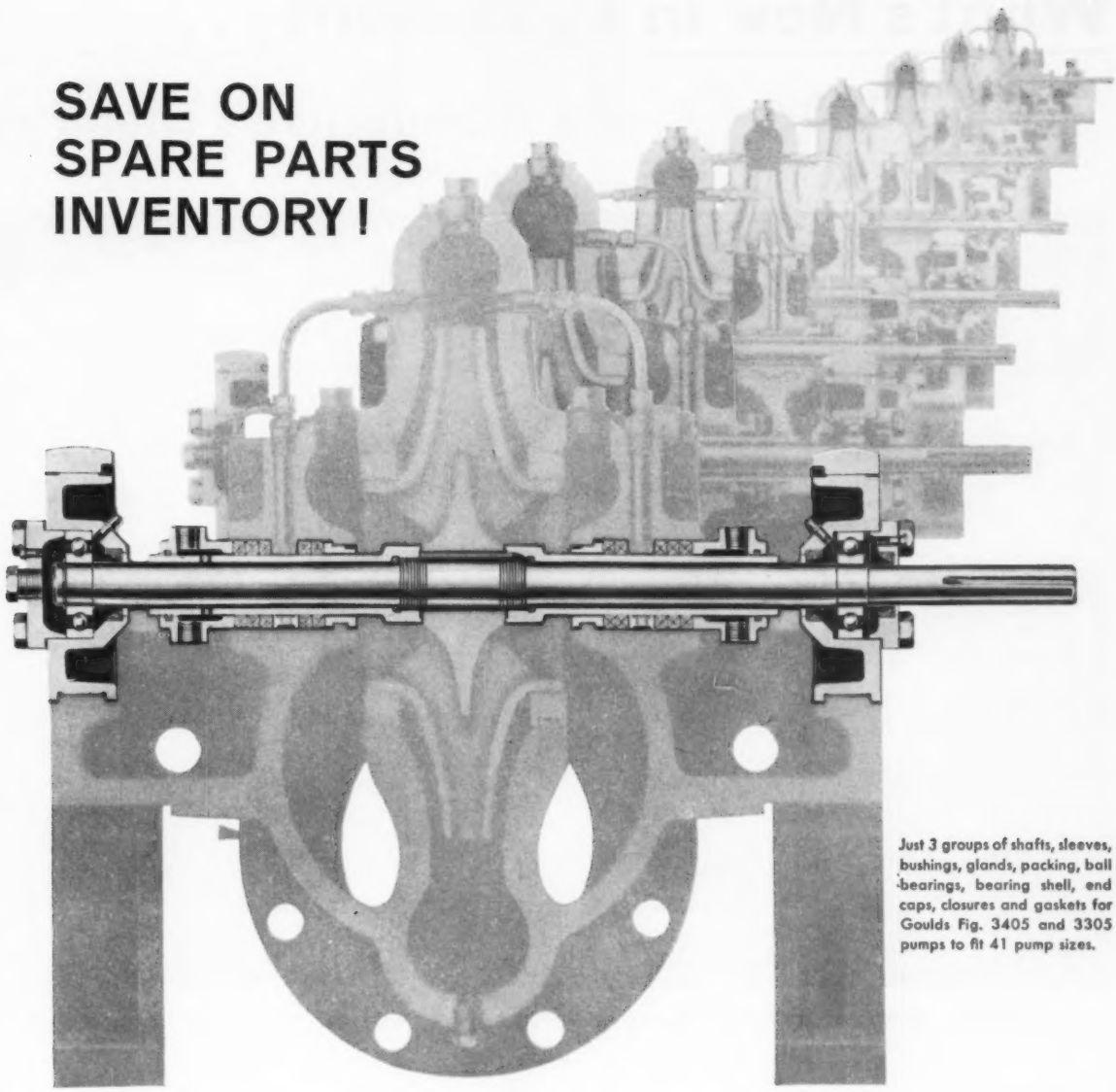
### HELP WANTED

**SALES ENGINEER WANTED**

Well established manufacturer of welding fittings has an opening for a young man in Sales Department. Must have engineering background and past association with refining/petrochemical industry. Will cover Texas and Gulf Coast area. Make your reply sufficiently complete to merit a contact for interview. Address Box 306-R, c/o PETROLEUM REFINER, Houston, Texas.

If You Want
*Fast*
Results . . . be
Sure
to
Use
Petroleum
Refiner
Classified Ads
They Don't Cost,
They Pay!

# SAVE ON SPARE PARTS INVENTORY!



Just 3 groups of shafts, sleeves, bushings, glands, packing, ball bearings, bearing shell, end caps, closures and gaskets for Goulds Fig. 3405 and 3305 pumps to fit 41 pump sizes.

## See how just 3 groups of parts fit 41 pump sizes!

High degree of interchangeability of parts on Goulds Fig. 3405 single-stage and Fig. 3305 two-stage Centrifugal Pumps helps you save four ways:

1. You cut down your spare parts inventory.
2. You can make changes in the field to meet new requirements.
3. Off-the-shelf delivery of standardized parts.
4. You can get lower initial cost, due to standardization of parts during manufacture.

Just three shaft and rotating parts assemblies provide for 41 sizes of these two popular pumps. You cut spare parts inventories *up to 91%*, save the cost of unnecessary overstocking.

Up to 82 pump combinations are possible—considering right- and left-hand rotation—and rotation can be changed in the field due to unique sleeve locking device (patented). Mounting dimensions and motor drive bedplates are standardized to facilitate changing without the additional expense of drilling and tapping.

*And* . . . you get all of this at low cost! Standard parts make manufacture less costly. Goulds passes on the savings to you.

Find out how this maximum interchangeability can save you money by sending for Bulletins 721.6 and 722.6, or ask your nearest Goulds representative.

GOULDS PUMPS, INC., Dept. PR-128, Seneca Falls, N. Y.

**GOULDS**

**PUMPS FOR INDUSTRY**



For more data on advertised products, use Readers' Service Cards, last page.

# What's New in Equipment . . .

## . . . and Manufacturers Literature

**Engineer examines new epoxy-nylon bonding agent which will effectively join wet and cured concrete.**

# New Concrete Bonding Agent Available

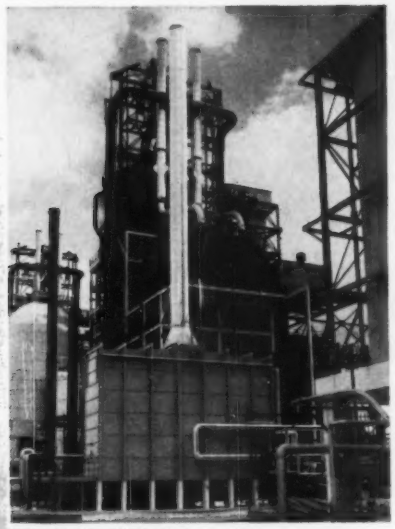
### "Uniweld" forms permanent joint plus water and vapor barrier—is tougher than hardened concrete

One of the oldest problems of the construction industry — joining fresh wet concrete to cured concrete—has been overcome with the development of a new structural welding agent.

Perfected after years of research, Uniweld is an "alloy" of epoxy and nylon type synthetic resins which forms a permanent joint and water and vapor barrier—literally welding the entire contact area without any mechanical interlocking. Tension, compression, shear and impact tests show that the bond is many times stronger and tougher than even fully hardened concrete.

Epoxies are the only known materials which will form a tenacious bond with cured concrete. Because Uniweld is thermo-setting rather than thermoplastic, the curing process is irreversible and permanent. It does not depend on the evaporation of moisture or solvents and is totally unaffected by water, alkalies, mild acids and many other reagents. The Uniweld actually forms a waterproof membrane over the entire bond area as well as a permanent high-strength bond.

Top concrete layer (photo dark color) has been permanently welded to the base cured concrete by Uni-



# every BORN heater is special

When you specify a BORN Heater, it's with confidence that it will do the job you want. Every BORN Heater is individually suited to the customer's requirements. That heater is **specially** made for you. That's the reason BORN heaters are specified time and again by clients whose names are the Who's Who of the Oil Industry.

For low first cost . . . high fuel efficiencies . . . close control . . . economical, trouble free operation . . . and exclusive safety features . . .

**specify BORN heaters.**

**BORN Engineering Company**

Manufacturers of Direct-Fired "UPFLO" Heaters

TULSA, OKLAHOMA

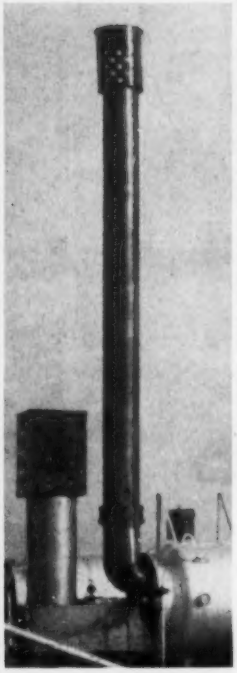
**BRANCH OFFICES:**
Denver, Colorado; Houston, Texas; Los Angeles, California; New York, New York; Shreveport, Louisiana

**IN CANADA:**
Canadian Brown Steel Tank Co., Ltd. Brandon, Manitoba, Canada



For more data on advertised products, use Readers' Service Cards, last page.

*INSTALL*
# MORAN POSITIVE DRAFT CONTROL
*on your heating units — AND —*



A Moran Positive Draft Control installation.

- INCREASE DELIVERABLE OUTPUT
- DECREASE FUEL CONSUMPTION
- DECREASE OPERATIONAL COST
- DECREASE MAINTENANCE COST
- INCREASE LIFE OF HEATING UNIT
- DECREASE STACK TEMPERATURE
- INCREASE STACK LIFE

## HOW "MPDC" WORKS

MORAN POSITIVE DRAFT CONTROL is a system for controlling the combustion air entering and leaving the heating unit. All combustion air *must* pass through a Moran Draft Equalizing Stack Head and capacity chamber before entering the intake of the heating unit. This Stack Head eliminates the effect of wind at the intake of the heater. After combustion takes place, all combustion gases *must* leave the heater through the heater stack, which is also equipped with a Moran Draft Equalizing Stack Head. This Stack Head eliminates the effect of wind at the top of the stack. This combination of two Moran Draft Equalizing Stack Heads, and a capacity chamber, is MORAN POSITIVE DRAFT CONTROL.

## WHY "MPDC" SAVES YOU MONEY!

- - - because with its installation you automatically eliminate all excess air not needed for combustion. *Excess air is very expensive.* Excess air not needed for combustion acts as a cooling agent, which *reduces* the *unit's deliverable output.* This reduced output necessitates the use of *additional fuel* to heat the excess air in order to reestablish the output desired.

The presence of excess air usually shows itself in the form of — increased fuel cost — operational fluctuations — the inability to carry peak load in high winds — and increased maintenance of equipment. When you eliminate excess air you remove the chief source of most heater inefficiencies.

**WHY THROW MONEY TO THE WIND? — GIVE YOUR HEATING UNITS A CHANCE TO PERFORM EFFICIENTLY. INSTALL MORAN POSITIVE DRAFT CONTROL — NOW!**

**MORAN "Peerless" Weatherproof Meter Houses • MORAN Safety Heaters • MORAN Exhaust Air Jackets • MORAN Safety Equipment.**

**MORAN**
**FURNACE AND SHEET METAL COMPANY**
807 E. 5TH PL. TULSA 20, OKLA.

## New Equipment...

weld. Constant water submersion will have no adverse effect upon a Uniweld bond, it is claimed.

Currently marketed concrete joining materials with rubber-latex, polyvinyl acetate, butadiene-styrene or other bases do not possess these properties—especially the resistance to all forms of moisture—and depend for strength primarily on a mechanical interlocking of the joined faces. Further, the Uniweld bond, which is only about .010 inch thick, develops its full strength faster than the newly poured concrete.

Use of the product is quite simple. The two components are mixed in equal volume—which starts the curing cycle—and a thin coating is applied to the surface by roller, brush or spray. The fresh concrete is poured directly on the Uniweld approximately 15 minutes later. Pot life of the mixed Uniweld, depending on temperature, is from one to two hours.

Coverage and cost vary according to the nature of the job, general condition of the existing concrete and porosity of the surface. In general, however, a gallon will cover up to 200 square feet at a cost as low as 5¢ per square foot. In many cases, savings in labor and materials will exceed the cost of the Uniweld. Permagile Corp. of America.

Circle E1 green card, last page

### Star Drill Automatically Sucks Dust While Drilling

A new self-rotating, air-operated, star drilling machine, which automatically sucks in any dust and chips which it creates when drilling in concrete, stone, marble, and other hard materials, has been introduced.

The new star drilling machine is designed for dustless operation in machinery installations, partitioning, water, heat, and electrical pipe or conduit drilling, and other industrial maintenance and construction tasks. It eliminates the nuisance and hazard of dust and chips by sucking them through hollow drilling steel—then into the tool and out ports in the back head into special dust-extracting tanks. The extractors are three plastic dust-collecting and air filter tanks mounted on casters for easy moving.

Operating in reverse of normal blowing action, a powerful venturi air siphoning action accomplishes the positive dust elim-

Photo courtesy Standard Oil Co. (New Jersey)

# LOOKING FOR MORE HEAT

## FROM THE FUEL YOU'RE NOW USING?

### AN AIR PREHEATER CAN PUT AN EXTRA 1000° INTO YOUR FURNACE

You can get more heat – from the same amounts of your regular fuel – with a Ljungstrom® Air Preheater. An Air Preheater can recover as much as 1000°F from the exhaust of stills or boilers and return it to the combustion air of any kind of fuel-burning equipment. Extra furnace efficiency will in turn permit use of advanced boiler designs, finer controls and a more uniform, more profitable product.

You save fuel with preheated air, too. Even if you recover only 45°F from stack gas, you'll save 1% of your fuel bill. Recover 1000°F, and you can maintain present operating temperatures *on 20% less fuel.*

There's also less maintenance on a Ljungstrom-equipped furnace. Fuel burns more completely in preheated air, so there's less slag, fewer deposits, higher availability of equipment. What you save on maintenance and fuel alone will pay for your Air Preheater in two years or less. "Write-off" can be cut to *as little as nine months* if you use the extra capacity of a preheated furnace to boost product quality.

**Free facts on fuel savings**

One company's fuel savings with an Air Preheater are factually described in an article by Oliver F. Campbell. Write today for your free copy.

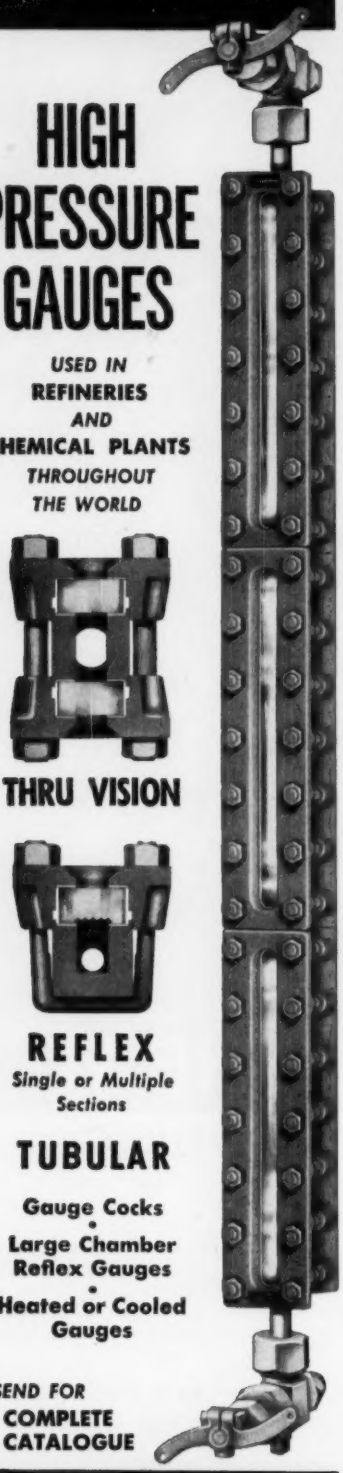
## THE AIR PREHEATER CORPORATION

*60 East 42nd Street, New York 17, N. Y.*

Strahman

HIGH PRESSURE GAUGES

USED IN REFINERIES AND CHEMICAL PLANTS THROUGHOUT THE WORLD



THRU VISION

REFLEX
Single or Multiple Sections

TUBULAR

Gauge Cocks
•
Large Chamber Reflex Gauges
•
Heated or Cooled Gauges

SEND FOR COMPLETE CATALOGUE

STRAHMAN VALVES, Inc.
16 Hudson St., New York 13, U.S.A.

## New Equipment . . .

ination with the new star drilling machine. The star drill rotates automatically during drilling. Thor Power Tool Co.

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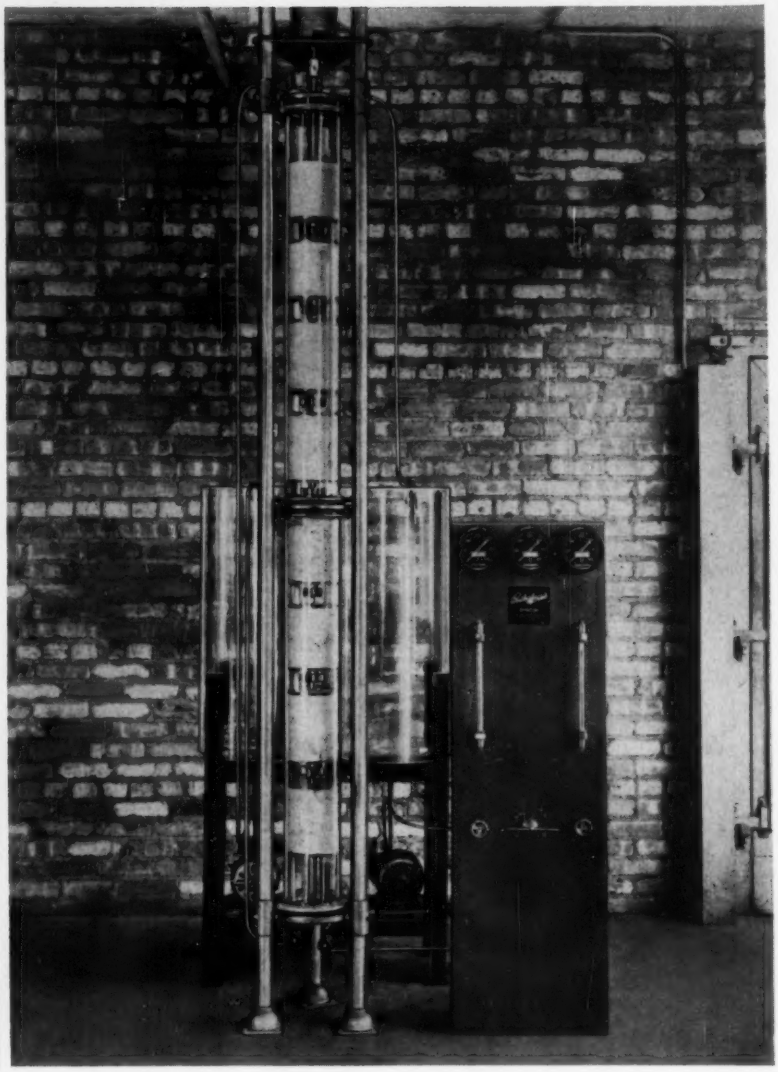


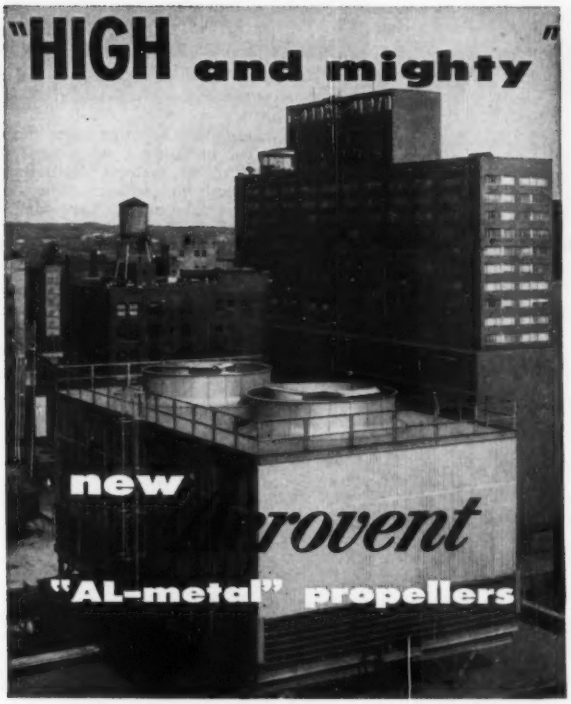
## Tool for Solvent Extraction Processing

The Spiradyne Column Extraction Plant is being offered as a completely engineered "packaged assembly." Each plant is tailor-made to customers' requirements, with a choice of either manual or automatic operational controls.

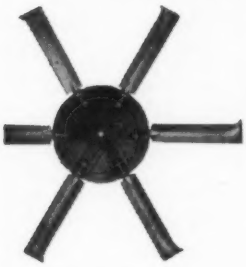
The Spiradyne plant is the answer to the ever-increasing demands of the researcher for new and unique processing equipment. This type of plant is designed to meet the needs of the industry for a low-cost, small capacity plant intended for pilot plant investigations or small scale production. It is especially applicable for the handling of systems where centrifugal force is not necessary for phase separation and where a specific solvent extraction system does not require the extreme versatility of the well-known contactors now in extensive use in processing operations.

The plant is available in capacities ranging from 20cc per minute to 20 gallons per minute. It is an inexpensive, flexible, and highly-adaptable new tool, ideal for use in every laboratory or commercial plant. It can be made ready for operation within a few hours after arrival in customers' plant.

The plant consists of a gravity-type column specially designed with highly-efficient impeller mixing sections for intimate contacting of two phases. The sections are assembled on a rotating shaft controlled by a variable speed drive unit. The clarification sections embody principles used in the firm's contactors. They are packed with highly-efficient coalescing materials necessary for phase disengagement. The design of these elements is based on many years of successful experi-




## move mountains - of AIR!
### in towers and exchangers



Developed originally for the petroleum industry, Aerovent Large-Diameter "Al-metal" Propellers, constructed of tough, durable aluminum alloy, move great quantities of air at high velocities, in heat exchangers and cooling towers. Pictured above are two 4-blade, 16-ft. propellers in a cooling tower installation. These mighty propellers, with adjustable-pitch "Macheta" Airfoil blades, are job-engineered to individual specifications.

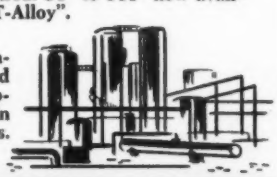
*Write for free Bulletin 510*

- Sizes 14' to 18'
- 4 or 6 blades

**DESIGNED FOR DEPENDABLE OPERATION!**

Endurance tests, conducted at *3 times* normal loading prove the ability of these new large-diameter propellers to withstand severe punishment. Heavy-duty cast steel hubs offer maximum resistance to stresses. Angle settings for each operating requirement, and appropriate alternate settings, assure accurate pitch for any predetermined performance which may be required. 54" to 144" now available in revolutionary new "T-Alloy".

REFINERIES, pumping stations, industrial plants and commercial buildings use Aerovent "Al-metal" Propellers in major air-moving applications.



*Aerovent* FAN COMPANY, INC.
LARGE PROPELLER DIVISION
304 Wright Bldg.
TULSA 3, OKLA.
Main Office and Factory
PIQUA, OHIO

A sleeve, raised and lowered within a non-magnetic tube, attracts or releases an Alnico magnet attached to a mercury switch. Basically, this is Magnetrol.

## MAGNETROL

**AS DEPENDABLE AS MAGNETIC FORCE ITSELF**

● No matter how specialized the liquid level control application, adapting Magnetrol to meet it presents no problem. Whether it's for high pressures, high temperatures, corrosive liquids or any other condition, a few "standard" modifications and the job is done! Operation is so simple no changes in basic design are needed. That's why Magnetrol "fits" practically any application — why "specials" are so often standard with us.

Because of the utter simplicity and dependability of its magnetic principle, Magnetrol has *infinite operating life.* There are no wearing parts to get out of order.

Magnetrols are available for controlling level changes from .0025-in. to 150-ft., with single or multi-stage switching. Our experienced engineering staff is at your service.

**MAGNETROL, Inc.**

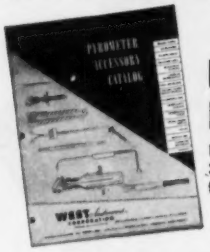
**WHY NOT MAIL THE COUPON — NOW**

Magnetrol, Inc., 2112 S. Marshall Blvd., Chicago 23, Illinois 7
Please send me catalog data and full information on Magnetrol Liquid Level Controls.
Name_____
Company_____
Address_____
City_____ Zone____ State_____




For more data on advertised products, use Readers' Service Cards, last page.

# THERMOCOUPLES
*for every industry*



**DATA BOOK**

New 32-page file book

★ Handily lists all data (I.S.A.) and
★ Graphically shows easiest way to select precisely the best thermocouple and protective tube for each operation.
★ Lists all components, with prices and
★ Provides handy reference for stock record.

**STANDARD AND SPECIAL**

For furnaces, ovens, kilns, moulding machines, pipelines, freezers, etc.

For use with all standard types of temperature indicators, controllers, recorders.

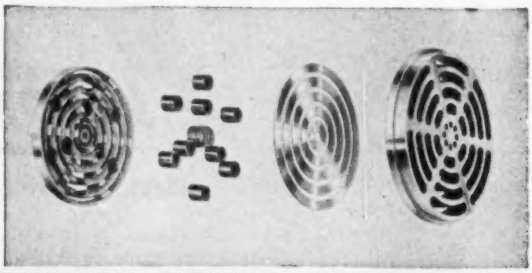
We make thermocouples from matched and checked wires to insure constant millivolt output for accurate readings. Complete selection.

**FREE** *write for your copy Now...*

**WEST** *Instrument* **CORPORATION**
CHICAGO
SALES OFFICES IN PRINCIPAL CITIES



# VOSS VALVES
**in your machine mean**



## LESS MAINTENANCE, FEWER SHUTDOWNS
**for your compressor.** (air, gas, ammonia)

**• up to 40% more valve area • minimum pressure loss • higher efficiency**
**• less power consumption • normal discharge temperature**
**• quiet, vibration-free • utmost safety • lower operating costs**

VOSS VALVES are made to specification, machined from solid stock (not cast)—using best alloy steels; for corrosion condition—stainless steels, such as 410, 18-8 or non-ferrous alloys—monel, inconel, etc. PLATES are machined (not stamped) and ground for precise close tolerance fit; are dimensionally stable . . . ductile . . . resist fracture, high temperatures and corrosion . . . withstand fatigue. SPRINGS of heavy rectangular sections and large diameters, add to dependability and safety.

*Our detailed proposal will be sent without obligation. Send name, bore, stroke and speed of machine.*

VOSS VALVES
REG U.S. PAT. OFF.
J. H. H. VOSS Co., Inc.
785 East 144th Street, New York 54, N. Y.


## New Equipment . . .

ence with centrifugal extraction and clarification.

The above assembly contains many flexible features for handling a wide variety of solvent extraction systems. Sufficient mixing and clarifying sections can be combined in a single unit to provide a range of definitely "identifiable" stages as may be required—up to 10 or more. Podbielniak, Inc.

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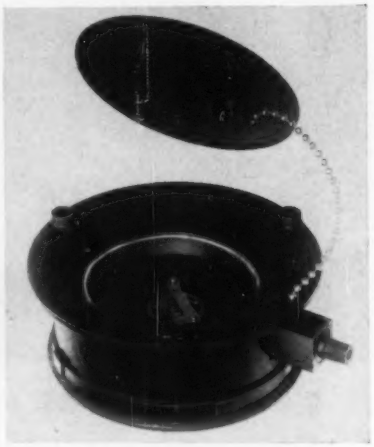


### Gages Protect Personnel With Nylon Blowout Back

A newly designed line of gages for positive protection of personnel in the event of tube failure has just been announced.

These Solid Front Gages cannot blow out toward the front as a shield is cast as an integral part of the rigid case construction. A full nylon back blows out at case pressures less than 2 psi should tube leak or fail. Design features allow full access for ease of adjustment, a sturdy fabricated socket assembly in a wide selection of construction materials, and special wrench grip on pressure connection. Bourdon tubes are of uniform fine grain and have high elastic limit and low hysteresis valves. The rotary, geared, all stainless steel movement is designed so that errors in angularity may be corrected by pivoting the movement around the pinion axis. The nylon blow-out back is securely retained to gage case by an extra strong stainless steel chain. The entire unit is weatherproof. Crosby Valve & Gage Co.

**Circle E4 green card, last page**

### Finds Oil and Phenols In Refinery Effluent

An instrument has been designed and developed specifically for the determination of oil and phenols in refinery effluents by means of API methods 733 and 717. It is a rugged, portable unit and easily operated as indicated by the following three steps:

- Setting monochromator for constituent to be analyzed (oil, phenol).
- Adjusting for full scale with solvent.
- Reading transmittance or absorbance

Plibrico *Construction*

THE *"pro"* OF *proficient* INSTALLATION

Follow-thru . . . that's the something extra which distinguishes the expert, be it in golf, tennis, fly casting, or baseball.

In refractories, quality products and capable engineering are fine, as far as they go. But for that something extra, your Plibrico distributor follows thru with his highly skilled, specially trained installation crew. The simple fact is they know exactly what they're doing when they install refractory linings in refining process equipment. And they do it well.

Proficient installation makes your Plibrico distributor's service truly complete. Products, engineering, and installation are yours from a single supplier, with responsibility undivided. Next time have the complete job done by your Plibrico man.

**Plibrico** REFRACTORIES ENGINEERING CONSTRUCTION

PLIBRICO COMPANY • CHICAGO 14, ILL.
*Plibrico Sales & Service in Principal Cities*

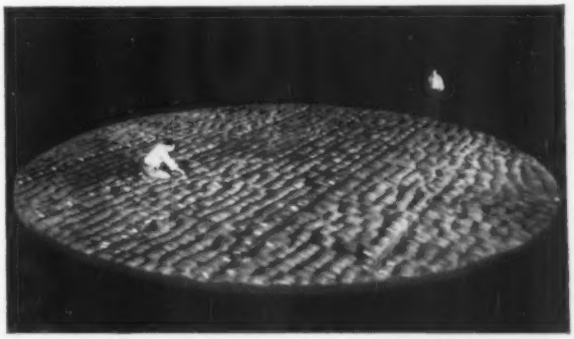
# METEX MIST ELIMINATORS

... the First name in knitted wire entrainment separators!

FIRST with strip-type construction
FIRST with wound-type construction
FIRST with Hi-Thruput mesh
FIRST with fiberglass coalescers
NOW FIRST AGAIN with POLYETHYLENE for maximum corrosion resistance!

Since 1943, when it first introduced knitted wire entrainment separators—Metal Textile has been consistently first in introducing new developments to the field. In response to requests from chemical and processing engineers throughout industry—Metex engineers have utilized new materials...developed special meshes ... initiated revolutionary techniques to provide low-cost, high-efficiency answers to the most complex entrainment problems. Your specific needs can be similarly solved. Our engineers, backed by the most extensive research and production facilities in the field, will be glad to recommend the type of Metex Mist Eliminator and method of installation best suited to your particular operating conditions. For latest design guides, write or call for Bulletin ME-9: Metal Textile Corporation, Roselle, New Jersey.

38' dia. Metex Hi-Thruput Mist Eliminator for world's largest vacuum pipe still.



METAL TEXTILE CORPORATION
*... world's largest and oldest producer of knitted wire products*
A DIVISION OF GENERAL CABLE CORPORATION




For more data on advertised products, use Readers' Service Cards, last page.

## New Equipment . . .

of sample extract directly on meter.

This instrument utilizes a specially selected grating with f/4.5 optics. Narrow bands are achieved by fixed slits yielding 8 millimicron bandwidth. The wavelengths are accurately adjusted at 2.82 and 3.43 microns for analysis of phenols and oil respectively. Analysis may be made with cells having path length from .01 to 5 cm (or any desired cell length made on special order). A thermocouple is used with its associated narrow band, low frequency, high gain amplifier. An electronically regulated power supply insures stable performance of the amplifier and metering circuity. Axler Associates, Inc.

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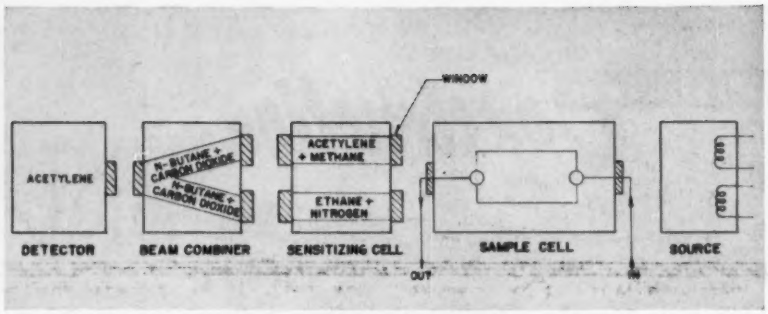



## Infrared Technique Cuts Analysis Error

A special infrared technique has been developed to enable accurate continuous measurement of a few ppm of acetylene in ethylene. When positive type infrared analyzers were first used they usually indicated higher concentrations than were found in laboratory analyses. Errors were traced to the method of sensitization. With conventional sensitization, cross sensitivities existed for other minor constituents. For example, 0.1 percent ethane could cause an error of 7 ppm acetylene. Methane and propylene gave smaller indications. These errors were overcome by means of a special "negative sensitization" technique which minimized the errors. Methane and propylene were made negatively sensitive to balance a positive sensitivity to ethane.

A problem of accurately measuring water continuously in liquid naphtha or a kerosine type stream was encountered in catalytic reforming units where it was necessary to keep a very low ppm level. Although a nondispersive infrared analyzer could be sensitized to the desired range of 0-200 ppm, variations in naphtha background, caused by changes in the feed stock, affected its accuracy. Infrared radiation was absorbed strongly and it was impossible to make the analyzer self-compensating for all feed stocks.

The difficulty was overcome by means of a sample system incorporating an automatic zero standardizing unit and a drier tower packed with Linde molecular sieves. Every two, four, or six hours the sample stream is automatically diverted through the tower for a timed interval. A potentiometer recorder then energizes a reversible motor geared to the zero control helipot of the analyzer. If the analyzer is not on zero it is reset to read zero and the system returned to the sample stream. Mine Safety Appliance Co.

Circle E6 green card, last page


100 YEARS

From Covered Wagons to Supersonic Speeds . . .

The great progress made by the petroleum industry during the last century has been due largely to the foresightedness of engineers and management.

The C. W. NOFSINGER COMPANY is proud to serve the vast Petroleum Industry with

Complete Engineering Services

*"In Engineering, it's the PEOPLE that Count"*

**THE C. W. NOFSINGER CO.**

*Engineers and Contractors for the Petroleum and Chemical Industries*

307 East 63rd Street Kansas City 13, Missouri

*Representatives*

WEST COAST—A. R. Chandler, 609 S. Grand Ave., Los Angeles 17, Calif.

GULF COAST—Russell G. Dressler, 204 Carolwood Dr., San Antonio 13, Tex.


## Cooling Tower Research Described In Booklet

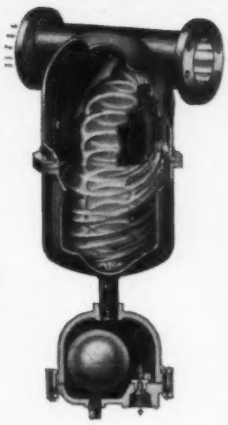
Recirculation, a new 12-page technical publication by the Cooling Tower Institute, describes a 7-year field research program upon which the development of a "recirculation factor" for industrial water-cooling towers is based. The new bulletin PFM-110 shows the factors and describes recommended procedures for their application. Suggested tower orientation for minimizing recirculation and the effects of one tower upon an adjacent tower is also diagrammed. This bulletin is considered a distinct addition to the technology of the industry.

Supplementing the new CTI bulletin,

## New Design Assures Maximum Entrainment Removal With Low Cost "T" Separator

Redesigned annular passage increases centrifugal force. Separated moisture, oil and solids travel outer wall to lower collecting chamber. Large diameter, high level outlet reduces velocity, eliminates entrainment problems. Screwed ends ½" thru 3". 125 lbs. flanged ends 2½" thru 8". Low cost in-line installation.

Combined with No. 90AC automatic drain trap to prevent loss of steam, air or gas provides most efficient and economical separator-drain combination available.



WRITE FOR BULLETIN TB-541-B

**WRIGHT-AUSTIN COMPANY**

3245 WIGHT STREET • DETROIT 7, MICH.

## MAISCH

### METERING PUMPS

- STAINLESS STEEL — OILLESS BEARINGS — STERILIZABLE
- POSITIVE DISPLACEMENT — SMOOTH, NON-PULSATING FLOW
- FOR HOT, COLD, VISCOUS OR WATERY FLUIDS
- ACCURATE WITHIN 1 TO 2%

Maisch Metering Pumps are simple in design, ruggedly built for long service, and can be depended on to maintain accuracy indefinitely. Exclusive design features insure optimum performance. Particularly suited for handling chemicals, syrups, oils, glue, processing solutions, etc. Quick demountable or fixed heads. Fixed capacity pumps available in wide range of output. Pumps in stock for immediate delivery. Write for complete details and prices.

**MECHANICAL PRODUCTS CORPORATION**

178 North Ogden Avenue • Chicago 7, Illinois

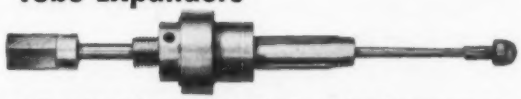
Keep Heat Exchangers on the Line with

## WILSON Maintenance Tools

### Heavy-Duty TP-301 Cleaner

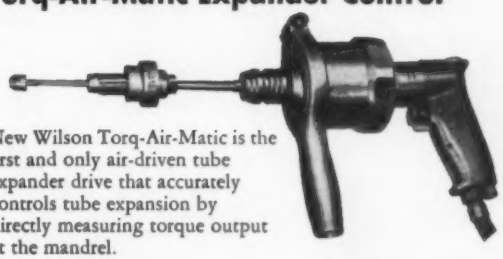
Positive air-driven, hollow rotary shaft, drill type tool. Tube is scavenged with air or water while cleaning.

### Tube Expanders



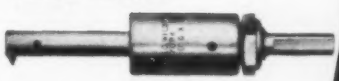
Wilson Models 41 and 44 Tube Expanders incorporate an improved, adjustable ball bearing thrust collar and are designed for efficient, easy rolling and maximum roll length adjustment for various tube sheet thicknesses.

### Torq-Air-Matic Expander Control



New Wilson Torq-Air-Matic is the first and only air-driven tube expander drive that accurately controls tube expansion by directly measuring torque output at the mandrel.

### Tube Cutter



Wilson tube cutter is easy to use and does a fast job. Cutter sizes and shanks available to meet all heat exchanger requirements.

**Write today for your copies of Wilson Tube Cleaner catalog No. 77 and Wilson Tube Expander catalog No. 88.**

**Representatives in principal cities**

**Thomas C. Wilson, Inc. • 21-11 44th Ave., Long Island City 1, N. Y.**

**Cable address: "Tubeclean", New York**

## WILSON

TW888

**TUBE CLEANERS • TUBE EXPANDERS**

## New Equipment . . .

for persons interested in detailed study of the field data, an appendix is also available showing all of the test data obtained from 30 separate operating towers. The new bulletin and the appendix, coupled with an earlier CTI technical paper entitled "Instrumenting a Field Study of Industrial Water-Cooling Tower Performance," form a complete report of the CTI research program which started in 1951. Each of the publications is available at nominal cost. A complete list of publications is available without charge. Cooling Tower Institute

Circle E7 green card, last page

## Mechanism of Oxidation Discussed In 12-Page Book

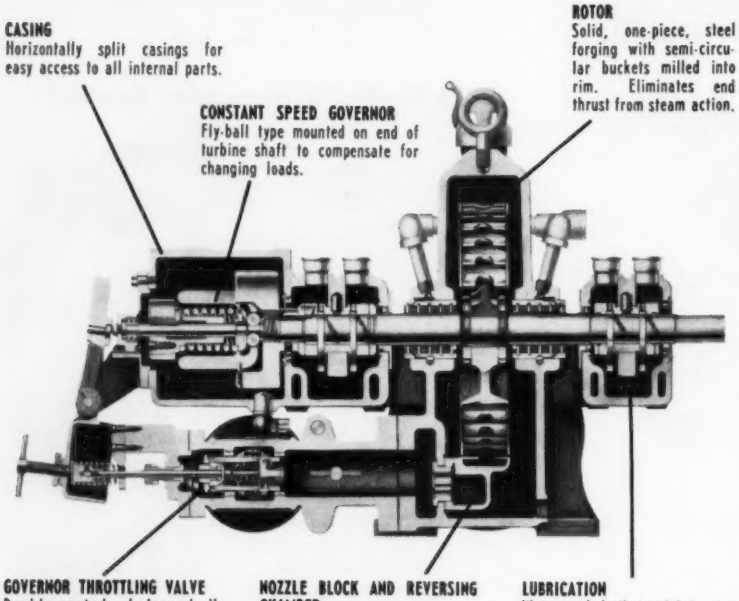
A professional discussion of the oxidation mechanism through free radical action provides the introduction of a new 12-page booklet entitled *Catalin Antioxidants.* Following this are detailed descriptions of the firm's antioxidant chemicals and their applications in gasoline and jet fuels, petroleum oils, rubber, plastics and packaging materials. Fully documented laboratory data is provided on physical and chemical properties as well as effectiveness of the antioxidants. Catalin Corp. of America.

Circle E8 green card, last page


Whiton

PRECISION ENGINEERED STEAM TURBINES

For almost 50 years, Whiton has combined experience, workmanship and **precision engineering** in building high quality, reliable steam turbines for all types of power and drive applications. Whiton horizontal, helical-flow, single stage turbines are available in 8 wheel sizes. Axial-flow, Curtis-blade turbines are also available. Write for complete data on Whiton's horizontal and vertical turbines.

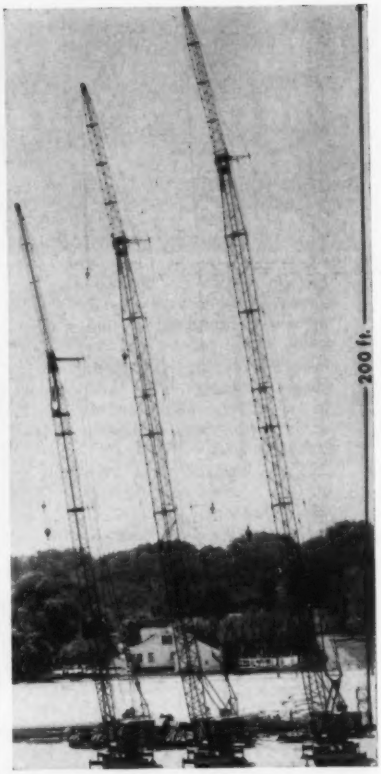

CASING
Horizontally split casings for easy access to all internal parts.
CONSTANT SPEED GOVERNOR
Fly-ball type mounted on end of turbine shaft to compensate for changing loads.
ROTOR
Solid, one-piece, steel forging with semi-circular buckets milled into rim. Eliminates end thrust from steam action.
GOVERNOR THROTTLING VALVE
Double-seated, balanced V-ported. Admits steam to assure stability control as load varies.
NOZZLE BLOCK AND REVERSING CHAMBER
One-piece unit. 2, 3, or 4 re-directing buckets as required for maximum efficiency.
LUBRICATION
Water cooled oil ring lubrication.

MAXIMUM OPERATING SPECIFICATIONS

| | |
|---|---|
| POWER | to 1200 HP |
| SPEED | to 8500 RPM |
| STEAM PRESSURE | to 1250 PSIG |
| STEAM TEMPERATURE | to 1050° FTT |

Whiton SINCE 1856

THE WHITON MACHINE COMPANY
NEW LONDON, CONNECTICUT


## Three Truck-Cranes Offer Special Lifting Features

Three new truck-cranes, capable of handling up to 200 feet of boom and jib, have just been announced. The 40-ton HC-108A will lift and handle, unassisted, 200 feet of the optional "Hi-Lite" tubular boom and jib, while the 35-ton HC-98A and 30-ton HC-88A handle 180 feet and 160 feet respectively.

The three Zephyrcranes offer many specialized lifting crane features designed to tailor the machines to any job requirements. Among these are Speed-o-Matic power hydraulic controls, reversing clutches for either or both main drums, independent rapid boomhoist with boom lowering clutch, pin connected crane boom, swing brake, retractable high gantry and hydraulic counterweight removal jacks.

Highlighting the list of carrier features are hydraulic power steering, removable front and rear outrigger boxes and beams, hydraulic controlled outrigger jacks and beams, planetary rear axles and four-axle carriers.

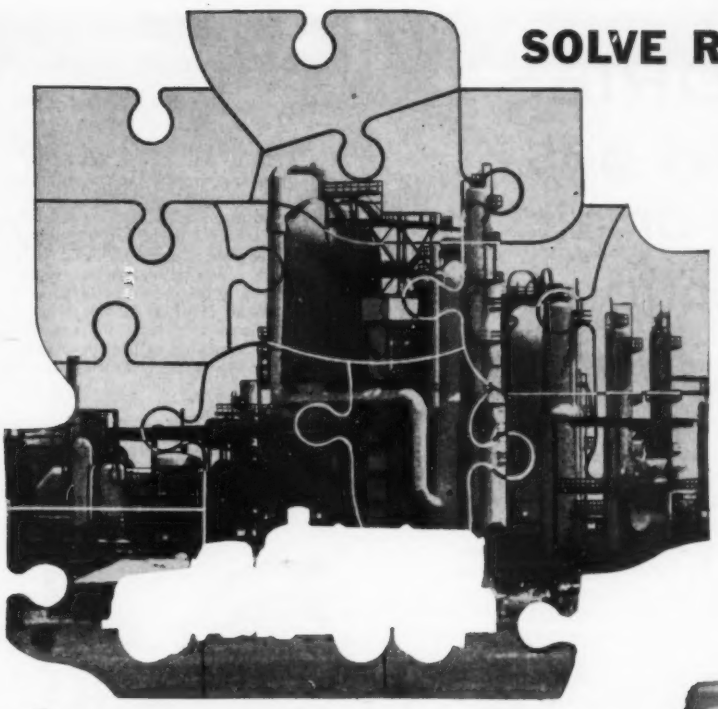
A new 12-page catalog for each model covers the details of these and other standard or optional features. Link-Belt Speeder Corp.

Circle E9 green card, last page

## Pressure Vessel Design Simplified by Handbook

A step-by-step guide that eliminates the need for lengthy computations in the design of pressure vessels has just been published.

This "Pressure Vessel Design Handbook" was developed to help engineers determine simply and quickly the size of a pressure vessel where the maximum



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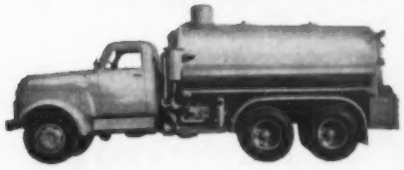
There's no faster way to move liquids or semi-solids than with vacuum. Pick-up is fast, and reverse pressure built up while "on the road" makes discharge even faster. And, unlike old-fashioned pump tanks, the load doesn't pass **through** the pump!

Standard sizes from 20 to 100 bbls; and units are skid, truck, semi or trailer mounted. Write today for illustrated folder, and a new booklet on Refinery Safety.

**This Cost-Cutting Tool**

**COMPLETES THE PICTURE!**



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SOLE LICENSEE TO MANUFACTURE VACUUM TANKS UNDER U. S. PATENT NO. 2522077.

## Spare the Chisel · Save the Parts USE KROIL

Don't ruin a valuable piece of equipment merely because some part is rusted tight. Apply Kroil, the amazing new chemical lubricant that creeps into millionth inch spaces (proved by laboratory tests), dissolves rust, supplies necessary lubrication and

**LOOSENS FROZEN PARTS**

18,000 of America's leading plants can't be wrong! They have used KROIL for 10 years and are still depending on it to save expensive labor and valuable parts. They say: "Kroil loosened bushings after a 12-ton press had failed" . . . "on repairing heat treat trolleys formerly destroyed every nut. Now Kroil saves them all, and time, too" . . .

You too should be using KROIL every day. Try it on money-back basis. Gallon $4.00; with Kroiler trigger squirt gun (shoots a drop or a stream 15 feet, if desired) $4.95, f. o. b. our factory.

**KANO LABORATORIES 1094 Thompson Lane, Nashville 11, Tenn.**

KANO LABORATORIES

## Your STRUCTURAL STEEL and STEEL PLATE FABRICATION ON TIME!

We pride ourselves for "on time" delivery. Thoroughly experienced staff of designers, engineers, and fabricators, to furnish the steel you want, when you want it. AISC members. ASME pressure vessels, tanks, heat exchangers, as well as structural steel. Location served by SP and MP railroads, and our dock is on the Intracoastal Waterway. Write, wire or phone for FACT FILE on our complete facilities.

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or air
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ROCKWELL "WAFER" VALVES

Wafer valve with air motor operator. *Right*—rubber-lined wafer valve with hand wheel control.

Compact, space-saving butterfly valves for dependable throttling and wedge-tight shut-off of air, gas, liquids and semi-solids at differential pressure to 900 psi and higher and temperatures from minus 300° to 2000° F. Manual or automatic operators. Standard sizes to 36" and larger special sizes. Write for Bulletin 580.

W. S. ROCKWELL COMPANY
2368 ELIOT STREET • FAIRFIELD, CONN.
*Sales Representatives in Principal Cities*


## New Equipment . . .

working pressure requirement and desired capacity or space limitations are known.

This handbook contains tables giving head capacity and shell capacity per linear inch for various tank sizes, ranging from 48 inches I.D. to 131¾ inches I.D. The computations to determine the various working pressures listed are based on the three steels most commonly used in pressure vessel construction; A-285 grade C; A-212 grade B and A-299.

The manual outlines in five basic steps the procedures to follow in determining size of the vessel once the basic requirements have been determined. American Car & Foundry Division, ACF Industries, Inc.

**Circle E10 green card, last page**

### Roll Grooved SS Fittings For Quick-Coupled Piping

A new line of Schedule 5 and 10 roll grooved stainless steel pipe fittings, just introduced for installation with Victaulic couplings, makes possible for the first time a complete quick-coupled, all-stainless steel piping system.

Stainless steel elbows, tees, crosses, returns, stub and blank ends, reducers, and reducing tees, with roll-grooved ends, are available from stock in sizes that range from 1¼ to 4 inches in diameter. Additional sizes of fittings can be promptly produced on order.

Strong, hard and tough, the new fittings are made from AISI Type 304 and 304L austenitic 18-8 chromium-nickel stainless alloy. They are also available in 316 and 316L alloy, containing some 11 percent nickel addition, for systems serving under more severe temperatures and corrosive conditions.

According to the manufacturer, the new fittings will reduce by half the cost of jointing Schedule 5 and 10 stainless steel piping when compared to welding or flanging. In addition, the availability of fittings in Schedule 5 will permit the use of this light schedule material in cases where heavier Schedule 10 piping was used only because of its easier welding characteristics and not because the extra strength was required.

These new fittings, joined with Victaulic groove couplings, are finding wide acceptance for the reason that plant

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Pressure Tube Nipples

A.S.T.M. A-83 and A-106

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⅛" to 1½" Standard and Extra Strong Weights, Black Grade "A."

½" to 1½" Double Extra Strong Weight, Black, Grade "A."

TO ORDER:

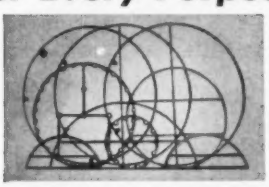
Grade "B," Galvanized, Cold Drawn in Larger Sizes.

• Avoid errors. Nipples are marked "SMLS" with Grade, Weight and A.S.T.M. Spec.

ID-3

Pittsburgh NIPPLE WORKS, Inc.
1455 SPRING GARDEN AVE., PITTSBURGH 12, PA.

GASKETS
For Every Purpose



HEAT EXCHANGER GASKETS

Made in any size or shape needed in double jacket type. Also cut from solid metal or sheet packing. Write for Bulletin 564.

CORRUGATED METAL GASKETS

Plain or jacketed type. Made of ingot iron, aluminum, stainless steel, copper, brass, nickel and monel in all sizes and shapes. Write for Bulletin 565.

PROMPT DELIVERIES

CHICAGO-WILCOX MFG. CO.

7719 So. Avalon Ave., Chicago 19, Ill.

## New Equipment . . .

down-time for pipe cleaning or alteration is reduced to an absolute minimum. The joint is leak-tight, able to withstand vibration or flexing, provides for some expansion or contraction, and a union at every joint.

The coupling utilizes a pressure-sensitive gasket that bridges the pipe ends, and a housing that fits snugly into circumferential grooves in the piping. The coupling is made tight with two bolts—or a specially designed toggle that opens or closes by hand, in one operation, without the use of any tool.

Installation of a complete Victaulic piping system, says the company, can be accomplished without special skill or previous experience. All that is needed is a socket wrench. If the purchaser prefers to groove his own pipe, Victaulic can also offer simple-to-operate and light-weight grooving tool that can be easily carried anywhere in the plant or in the field. Victaulic Company of America.

Circle E11 green card, last page

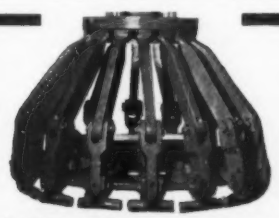
### Pneumatic Recording Gas Chromatograph Is Released

A pneumatic trend recording Industrial Gas Chromatograph has been released.

The new readout system permits the advantage of continuous easy checking of the components of interest, as well as offers a major step forward in controlling process operations by cascade control through chromatography.

Several pneumatic miniature recorders present analysis data. Some of these recorders are two-pen units which trace trend concentrations of two components. Another recorder traces a chromatograph of the analysis for use in calibrating and adjusting the instrument.

It works like this: Analysis by the standard chromatograph results in an electrical signal output for each component of interest. The signal is transformed by a transducer to a pneumatic signal proportional to the quantity of component. When the signal into the transducer reaches a maximum, the transducer freezes at the maxima; simultaneously a timing device programs the opening and closing of the valves to the pneumatic receiver and mem-



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for handling greases and other viscous fluids.
• No operator required.
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Fills, seals, stamps and counts lug cover pails. Output of 15 pails per minute. Write for details on installation to meet your requirements.

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Haydite aggregate used with Lumnite cement produces refractory concrete suitable for sustained temperatures up to 1800-2000° F., which makes it excellent for tubular heaters, ducts, flues, stacks and catalytic crackers. Weighing from 30 to 40 per cent less than ordinary aggregate concrete, Haydite is exceedingly strong. It has excellent insulating properties and withstands pressures of up to 1130 pounds per square inch. Write today for free folder and complete information about Carter-Waters Refractory Haydite.
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For more data on advertised products, use Readers' Service Cards, last page.

# Outstanding Accuracy

# PALMER

## Dial Thermometer

**Check these functional features**

- Direct-drive Bourdon Coil with a filled system for longer lasting accuracy.
- Stem can be placed at any desired angle and case can be rotated to most readable position.
- External calibration for zero setting.
- Unaffected by stem alignment.
- Accurate to one scale division.
- No sticking at any temperature.
- Non-corrosive case.

# PALMER

**THERMOMETERS, INC.**

Mfrs. of Industrial Laboratory, Recording and Dial Thermometers

2515 Norwood Ave., Cincinnati 12, O.


## New Equipment . . .

ory units. This timer also programs the restoration of the transducer system to operation from the frozen position after the peak value is properly stored.

The pneumatic signal for each component is transmitted from the pneumatic memory system to the recorder, resulting in a quantitative trace of the signal peak. The memory unit maintains pressure so the signal to the recorder continues when the electrical signal to the transducer returns to zero. This gives a continuous trend trace of component concentration. Each component of interest is analyzed and recorded in this manner.

Continuous, line trace of each component of interest gives at-a-glance information on concentration trends in the process. There is a single curve for each component. This allows the measurement of a critical component to be used as a control point for the operation. Beckman/Scientific and Process Instrument Division.

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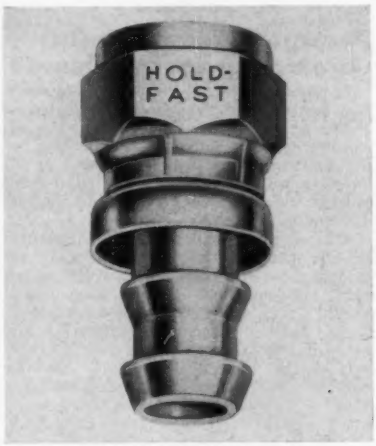


### Low Pressure Coupling Makes Hose Removal Quick

A new line of low pressure "Hold-Fast" Couplings has just been designed for general, low pressure, hydraulic and fluid transfer service.

Because attachment or removal from the hose is quickly and easily accomplished, without the use of tools, the new couplings are especially well adapted for fast, emergency field repair.

A wide range of styles and sizes is available, including couplings suitable for virtually every general, low pressure application. As they are reusable, their adoption permits substantial economies and minimum replacement inventory requirements.

Assembly is quick and uncomplicated, since the hose is simply forced over the stem until it seats against the bottom of the protective cap.

To complement these new low pressure couplings, Anchor is introducing two new styles of low pressure, 1-cotton braid hose. Style No. PR has a synthetic rubber inner tube and cover; Style No. PW is of similar construction except that it has an abrasion resistant braided cotton cover that is impregnated with an oil and mildew resistant synthetic rubber compound. Anchor Coupling Co., Inc.

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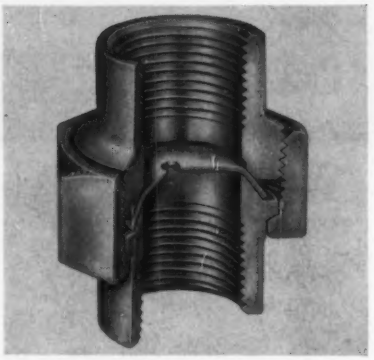

### Gasketless Orifice Union Has Cup-Shaped SS Orifice

A new product is available which features a cup-shaped stainless steel orifice plate that fits into place between the conventional pipe union head and tail pieces to form a tight, leakproof seal with ground joint steel to stainless steel seats. Separate gaskets are eliminated as is the previous uncertainty of the gasket type needed for specific temperature and pressure requirements. The new Cup-Orifice Unions are made in ⅛-inch to 2-inch pipe sizes, inclusive, with a 3,000 psi pressure rating. Catawissa Valve & Fitting Co.

**Circle E14 green card, last page**

### Moly Compound Shortens Machinery Wear In Period

A new molybdenum disulfide compound which offers distinct advantages in the reduction of damage during "wearing in" (breaking in) of new machinery, has just been announced.

The new compound:

- shortens the "wear in" period without the use of abrasives.
- reduces the galling, seizing and excessive wear during this critical period.
- offers the best safeguard against shipping delays, and the expenses associated with disassembly, repair and replacement of damaged parts, reassembling time, etc.
- need not be burnished into surface for maximum effect.
- is inexpensive . . . a little goes a long way. The Alpha-Molykote Corp.

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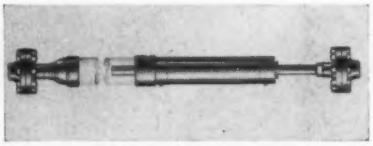

### Hydraulic Snubber Resists Shock and Vibration Loads

Engineers responsible for pipe stress analysis in the design of piping and high temperature process systems for petroleum refineries and chemical plants will be interested in a new product just introduced. This device, never before offered commercially by any manufacturer as a completely engineered product, is a hydraulic vibration snubber designated by the trademark name "Vibrasnub."

The "Vibrasnub" Hydraulic vibration Snubber functions as a stop or restraint

for dynamic vibration and shock loads. Such rapid movements may or may not be accompanied by a slower, natural movement, such as thermal expansion or contraction. The rapid vibration movements are restricted by the snubber assembly. The more gradual thermal movement is accommodated by by-passing hydraulic fluid through a restricted orifice in the piston of the snubber cylinder. The "Ball Type" Strut Joints on each end of the assembly permit —10 degree alignment movement to eliminate binding.

With the "Vibrasnub," shock or vibration loads are resisted instantaneously! It is not a dampner which merely decelerates movement. Deceleration combines time with movement and, frequently equipment subjected to small vibratory movements is unaffected by spring-type dampners.

The Snubber Assembly involves only a nominal pressure drop across the by-pass orifice against a slow thermal movement whereas spring-actuated type dampners usually subject the equipment to an appreciable pre-load and functional force before the equipment may make such movement. Barco Mfg. Co.

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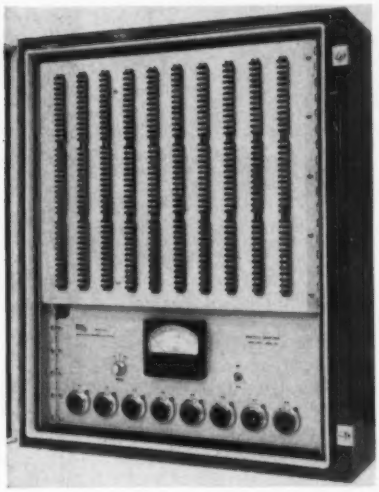

## Transistorized Analog Computer Accurate To 2%

The CM-2 analog computer is a completely solid-state computer which can reliably perform all-purpose mathematical computations. It consists of operational amplifiers, logarithmic networks and scaling potentiometers. Use of transistors and magnetic amplifiers in place of vacuum tubes provides the reliability and ruggedness needed for industrial applications. An integral programming board inside the cabinet facilitates programming of functions. The CM-2 meets Class 2, Section 1 conditions with an air purge. It has wide applications for computation and control of variables in chemical, petrochemical, refining and process industries, and can increase efficiency, product purity and overall profitability by eliminating human error in the computation and control of set points and by optimizing existing control conditions. The over-all accuracy is better than 2 percent. Southwest Industrial Electronics Co.

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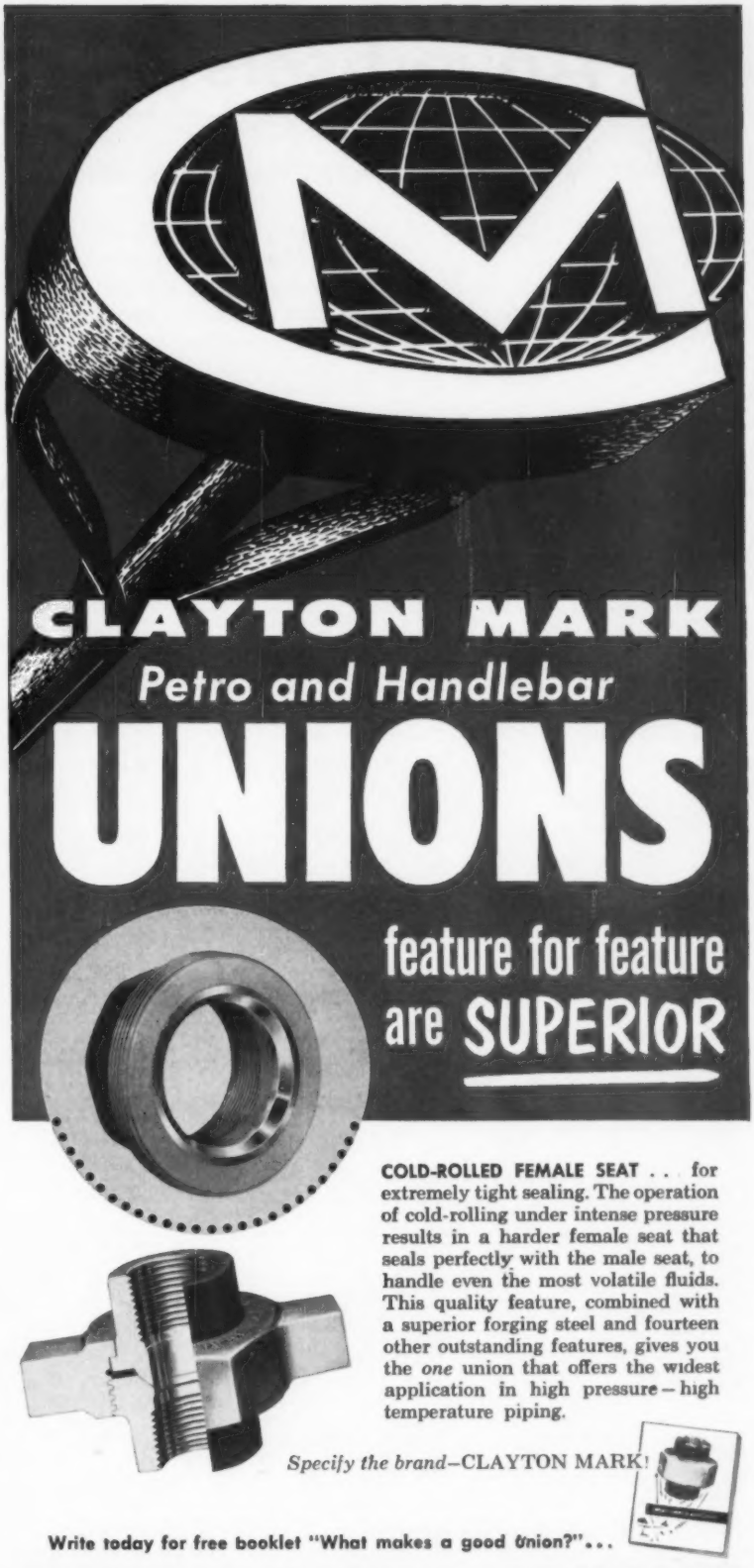
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feature for feature
are SUPERIOR
COLD-ROLLED FEMALE SEAT . . . for extremely tight sealing. The operation of cold-rolling under intense pressure results in a harder female seat that seals perfectly with the male seat, to handle even the most volatile fluids. This quality feature, combined with a superior forging steel and fourteen other outstanding features, gives you the one union that offers the widest application in high pressure – high temperature piping.
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Write today for free booklet "What makes a good Union?"...
CLAYTON MARK & COMPANY
1900 Dempster Avenue • Evanston, Illinois




For more data on advertised products, use Readers' Service Cards, last page.

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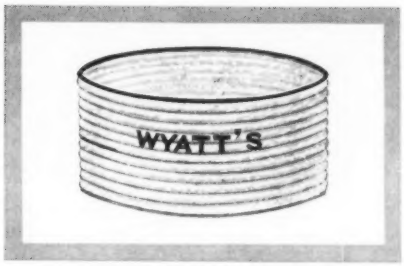


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